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THIRTIETH ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1893.

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Commonwealth of Massachusetts.

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, Jan. 11, 1893.

To the Honorable Senate and House of Representatives.

I have the honor to transmit herewith to your honorable body the Thirtieth Annual Report of the Trustees of the Massachusetts Agricultural College.

I am, very respectfully,
Your obedient servant,

HENRY H. GOODELL,
President.

ANNUAL REPORT OF THE TRUSTEES

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

To the Honorable Senate and House of Representatives.

The past year has been one of marked progress. Not only has the attendance been the largest in the history of the college, but it has been distributed over a greater area of the State, and a larger number of towns have been represented. Tabulating the results, we find that, of the one hundred and ninety students present during the year, sixteen were from without the State, and the remaining one hundred and seventy-four represented one hundred and ten towns. The growth of the college during the past six years has been steady and healthy, showing its gain in the popular estimation. From entering classes of thirty-three and thirty-five, it has advanced to sixty-two in 1891 and forty-six in 1892. The large falling off this year resulted from the insufficient preparation of the candidates, more than one-third having been rejected on account of failure to meet the requirements for entrance. The most noticeable gain, however, has been in the numbers of the graduating classes. The gain has been nearly one hundred per cent. It is surely a significant fact that the proportion of men now completing the course is much larger than in the earlier days of the college. Of the six hundred and forty-three who had entered and left the institution prior to 1886, thirty-seven per cent had graduated; while since that date two hundred and thirty-six have entered and fifty-two per cent of that number have been graduated. This is due partly to the liberal policy of the State in increasing its equipment and providing additional

facilities for instruction, and partly to the better knowledge of the college and its aims and purposes. One young woman, braving the discomforts of being the only one of her sex in college, joined the freshman class and did most excellent work, but lack of funds compelled her withdrawal before the close of the first term. There is no reason why the young women of the Commonwealth should not avail themselves of the opportunities offered here. The doors are open, and they will be welcomed both by teacher and student.

The history of any institution is written in the lives of its alumni; and here we have a record of which the State may be justly proud.* Since the college opened its doors to students in the fall of 1867 it has received within its walls (not including students now pursuing the course) eight hundred and seventy-nine men. Of this number, three hundred and sixty-one have completed the prescribed course of study and received the degree of Bachelor of Science. Three hundred and forty-eight are living. Complete statistics of three hundred and thirteen of these men, the graduates of the last class not included, are at hand; and examination reveals the following facts: Considerably more than one-half of the entire number are either farmers or engaged in closely allied pursuits. There are ninety-two farmers, and the remainder are distributed as follows: agricultural editors, four; fertilizer business, seven; teachers in agricultural institutions, twenty-one; experiment station directors, three; veterinary doctors, eight; professors of veterinary science, two; assistants in experiment stations, twenty-two; assistants in the Board of Agriculture, two; Gypsy Moth Commission, two. I desire particularly to call attention to the prominent positions occupied by our graduates in agricultural colleges and experiment stations throughout the country. No other agricultural college has furnished so many men for such positions. One-seventh of all our graduates are employed in agricultural colleges and experiment stations. They are scattered all over the country, and among them we find three college presidents, eight professors of agriculture, five professors of horticulture and botany, three directors of experiment stations and several vice-directors. This indeed is a

* From statistics compiled by Prof. William P. Brooks.

record to be proud of for an institution that graduated its first class barely twenty-one years ago.

Among those not connected with agricultural pursuits we find nine lawyers, eighteen engineers and eleven teachers. Medicine claims no less than eighteen men, and there are two dentists and five clergymen. Our graduates touch agriculture, however, at other points. Wherever they are found they are usually prominent in every movement which tends to uplift the agricultural classes. Thus we find among them numerous presidents and secretaries of our agricultural societies and members of the State Board of Agriculture. Two have been masters of the State grange and two lecturers, and they are everywhere at the head of local granges, farmers' clubs and agricultural organizations.

The increasing attendance has resulted in overcrowding the buildings. Every room in the dormitories has been occupied by two or more persons, while a number have been compelled to seek lodgings elsewhere. It becomes a serious question for the State to consider whether or not it will increase its dormitory accommodations. If succeeding classes prove as large as those of the past years, it will be impossible to provide quarters of any description for them. The recitation rooms, furthermore, are entirely inadequate either in number or size. The same room has to be used in turn by several professors. This is a serious inconvenience when apparatus has to be brought in and removed, or when preparation beforehand is required for lecture. The teachers of physics and chemistry, for example, do not want their desks strewn with the bones and separable joints of the veterinary department, when the whole available space is required for the adjustment of apparatus used in illustrating the principles of electricity or gases. Furthermore, in a room overcrowded with students it is impossible to secure proper ventilation, or preserve the same good order and discipline as in one with fewer occupants. I submit that a room 18.10 feet by 32, and 12.9 high, containing 7,684 cubic feet, is not a proper place in which to confine a class of thirty or forty young men for an hour, especially when during the hour previous it has been occupied by a class of like size.

The chemical department has quite outgrown its quarters, and demands additional space. The time is not far distant when a building will be required for it alone, containing laboratories for practical work and lecture rooms where the theory can be taught. As a temporary expedient, it has been suggested to hold all religious exercises in the new stone chapel, and fit up the room now used for daily morning prayer as a laboratory for advanced workers. This, however, can be only a temporary arrangement, for the reasons contained in the paper herewith submitted, from the professor in charge: —

For beginners in the subjects here studied, there are the same provisions which have hitherto been offered. But these students, and in a greater degree the advanced students, are seriously impeded in their practical work by lack of room, and annoyances arising from the present deteriorated condition of the laboratory building. Advanced students are constantly increasing in number, but there is a great lack of suitable accommodations. They should be offered the best possible facilities for study, or they will go elsewhere to institutions where such are offered. At present, for lack of space, the advanced workers must take their chances in the same room with the beginners, where they are crowded and constantly liable to disturbance. A separate room should be provided, in which their operations would be safe from encroachment. The need of a more substantial building for this department becomes more and more apparent. The constant jarring and shaking of the building prevents the permanent setting up of balances and other apparatus. Whenever classes pass up and down stairs, or the bell is rung, every instrument and piece of apparatus is disturbed. Crevices about the windows and in the walls are continually increasing, in spite of constant repairs. Wind and dust penetrate from all sides, so that it is impossible to preserve apparatus in a cleanly condition. As a temporary arrangement, I would suggest the use of the present chapel room as a laboratory. One thousand dollars would be required to adequately equip it, and then it would serve until an appropriate laboratory building could be provided.

CHARLES WELLINGTON,
Associate Professor of Chemistry.

THE AGRICULTURAL DEPARTMENT.

This department has for many years been hampered by the condition of its barn and outhouses. While the work of

improvement has gone steadily on in every other direction, this alone has remained almost stationary. Patched up and altered from time to time, it still remains what it was originally,—inconvenient in its arrangements and inadequate in its provisions for maintaining the health of the animals housed within it. The college barn should be an object lesson to every farmer visiting the grounds; it should be a means of instruction to every student. Unfortunately, its only use as an object lesson can be to hold it up as a signal illustration of what ought not to be done. Defective in its sanitary arrangements, unfortunate in its location and old-fashioned in its construction, it is in every way unfit to be a representative structure on the grounds of the agricultural college of the State. The urgent reasons for its being replaced at as early a date as possible are ably set forth in the special report of the professor in charge, herewith appended: —

AMHERST, Jan. 3, 1893.

Pres. H. H. GOODELL.

DEAR SIR: — I deem it my duty to call your attention to the fact that a new barn in a new location is urgently needed in the department of which I have the honor to be in charge. I will state the reasons as they appear to me as briefly as I can.

First. The location of the present barn is most inconvenient, from a farmer's stand-point. A fundamental principle in the location of farm buildings is that they should be centrally located with reference to the fields to and from which there must be most cartage of materials.

When the whole college estate was tributary to this barn, its location was not a bad one; but now that a large portion has been set aside for the use of the State Experiment Station and the horticultural department, and the growth of the institution has necessitated the use of a further large slice of the estate for buildings and landscape purposes, the barn is left, if I may so express myself, stranded in one corner of the farm proper, upon its very highest point, and within a few hundred feet of its southern boundary. The improvement of that section of the farm, but a few years ago an old stump and brush pasture, has given us seventy acres of highly productive land, all much lower than the barn and at an average distance of something like a half mile; while a part of it is almost one mile, as we must travel by our roads, from the barn. The effect upon the expense of doing our farm work may readily be imagined.

Second. The growth of the college has made new buildings necessary in the very near future; and the place where the farm buildings stand will be needed for one of them, or, even if no building is placed upon the actual spot where the barn stands, its close proximity to dormitory or lecture rooms would be exceedingly undesirable.

Third. The construction of the present barn is such that the performance of the necessary work in the care of our large stock is very inconvenient; and, worse than this, it is not possible to insure even measurably perfect sanitary conditions. The arrangement with cellar beneath, and a large, broad, low-ceilinged stable above, makes pure air in that stable a practical impossibility. The college should have a barn which can be looked upon by the farmers of the State as a model. Ours is wholly behind the times, and a model only of inconvenience and rather of what a barn should not be than of anything for others to imitate.

Fourth. If we are to continue to use the present buildings, additions to satisfy our growing requirements, and numerous and expensive repairs, will be needed at once. In view of the fact that the location is inconvenient, and that the growth of the institution will soon make the removal of these farm buildings an absolute necessity, it would appear to be folly to continue the expenditure of money in this place.

Fifth. The candid consideration of those points thus far made must, it appears to me, lead to the conclusion that it is best to build a new barn now; but the most important point remains to be noticed. In spite of our utmost attempts to disinfect our barn, it appears to be thoroughly infected with the germs of tuberculosis. The first case of this disease in our barn occurred before 1880, and from that time to the present, losses of valuable animals have occasionally happened. When I assumed responsibility for the management of the college farm, in 1889, I found two animals in the barn affected with tuberculosis. These were slaughtered, and matters were allowed to run until the winter of 1890, and there was little indication of the presence of the disease.

Becoming somewhat alarmed, in view of the statements of certain veterinarians as to the condition of our herd at this time, Dr. James B. Law was called in. He made a thorough examination of every animal in the barn, and sent in a report which, as you are aware, was quite reassuring in its character. Two animals slaughtered by his advice were found diseased at this time; but, acting upon his suggestions as to disinfection, ventilation, etc., no further trouble was experienced until the winter of 1890-91, during which we slaughtered nine animals in the early stages of

this disease. Since that winter we have had occasional cases, but in no single season as many. Still, it appears to be impossible to eradicate the disease in our present stable. That it is greatly aggravated by the breathing of impure air cannot be doubted. The disease makes no progress as a rule in summer, when our animals have pure air. It is impossible to give them such air in our stable as at present arranged with the cellar for manure below. It is imperative that we have a barn constructed in such a manner as to secure better hygienic conditions. With such conditions we may yet have occasional cases of tuberculosis for a time, for the disease is everywhere among New England cattle, and it is most insidious in its approaches; but, having perfect sanitary conditions, I should confidently anticipate controlling it, — keeping it within very narrow limits from the first, and perhaps ultimately eradicating it from our herd.

Massachusetts, with her proud record in dealing with the various contagious diseases of domestic animals which have at various times gained a foothold within her borders, certainly owes it to herself and to her citizens to make the attempt here at her Agricultural College to control or stamp out this disease, — the most dangerous of all to the human family. Her legislators should not rest a day with the stigma which will lie upon our dear old State should this duty be longer neglected. We have tried long and faithfully to cope with this disease in our present quarters, and are most fully convinced that the struggle there is hopeless. The exigencies of the case demand something better, something which will provide ampler air space, better ventilation and improved facilities for cleanliness and the convenient use of germicides.

Very respectfully yours,

(Signed) Wm. P. Brooks,

Professor of Agriculture.

To carry out this plan, building a new barn worthy of the State and the college, moving and refitting the farmhouse and providing a new ice house and dairy, a considerable outlay will be required. For dairy purposes a much larger amount of space is required than is at present available. If the economical disposition of our dairy product be our sole object, then the present accommodations are ample; but we should have a room large enough, not only to accommodate a whole class of students, but also to contain the latest forms of dairy apparatus, — separators, butter extractors, churns, butter workers, milk aerators, etc., — in short,

a complete plant for practical instruction in matters pertaining to the dairy, as well as for laboratory work in the study of milk and its products.

In 1885 the total value of the agricultural products of the State was $47,756,033. The value of the dairy products at the same period was $13,080,526, and since then it has increased more rapidly than any other single industry. Other States are establishing or have established dairy schools in connection with their agricultural colleges. If we would keep abreast of the times, if we would offer our students the same advantages as elsewhere, we must in like manner establish schools where the best instruction can be given in this growing industry.

The Horticultural Department.

Great improvements have been made in this department during the past year. The eight thousand dollars granted by the State has been wisely and carefully expended. The whole Durfee plant house has been remodelled, the wooden benches replaced by stone, the old heating apparatus exchanged for new, and extensive additions made for the purpose of raising roses and vegetables. A tool house containing carpenter and blacksmith shop, storerooms and open sheds, has been erected, and a cold grapery nearly completed. The lateness of the season was especially favorable for building operations, and no loss of plants by frost was experienced.

The necessity for large quantities of ice for dairy purposes, and in the cold storage room for the preservation of fruit, led to the construction of a dam across the little stream flowing through the college grounds at a point midway between the botanic museum and the north dormitory. Distance from any pond of water and the trouble and expense incident to drawing the ice has at various times caused the throwing of temporary barriers across the brook; but the constant undermining of the earth by musk rats, and the danger incident to the sudden rising of the water after protracted rains, led this year as a matter of economy to the building of a substantial stone dam. This has been satisfactorily completed under the supervision of a graduate of our first class, Mr. William

Wheeler, and has resulted in the flowing of a considerable area. Looking at it simply in the light of ornamentation, it is a great addition to the college grounds, and furnishes the one thing needful to make the landscape perfect, — a water view.

The Experiment Department.

Four bulletins, in editions of eleven thousand, have been published during the year, on the following subjects: —

No. 16. Electro-culture, and experiments with lettuce under the influence of dynamical electricity.

No. 17. Experiments with fungicides and insecticides.
Testing new varieties of grapes and peaches.
Protection of peach buds.
Amount of copper on sprayed fruit.
Siberian crab as a stock.
Girdling grape vines.
Report of spraying apparatus.

No. 18. Fertilizers for potatoes, oats and corn.
Use of muriate of potash with manures for corn.
"Special corn fertilizer" *versus* fertilizer rich in potash.
Comparison of corn and millet as grain crops.
Proximate composition of potatoes, as affected by fertilizers.
Report on oats, hemp, flax, English wheats, Japanese millets and beans.

No. 19. The gypsy moth.
Barnard's insect trap.
Effect of damp weather on Paris green in burning foliage.
Kerosene emulsion as an insecticide for plant lice and red spiders on rose bushes.
Formula for preparation of kerosene emulsion.
Amount of Paris green to be used in showering apple trees.
The cranberry insects.

From the meteorological division, a monthly report, in an edition of four hundred copies, has been issued, covering all meteorological phenomena for each day. Expensive additions have been made to the apparatus, with a view to securing more complete results.

In the agricultural division, the barn destroyed by fire in

1891 has been replaced by one more commodious in every respect, and better adapted for purposes of experiment.

The work of the different divisions during the year is briefly outlined in the reports of the several officers herewith submitted: —

The Entomological Division.

Two bulletins have been issued from this division during the past year. The first, No. 19, contains the history and description of the gypsy moth in all its stages, illustrated with six plates, one of them in colors, and one a map showing the distribution of the insect; a description of Barnard's monitor moth trap, with an illustration; an account of experiments with Paris green on apple trees and tent caterpillars, and also with kerosene emulsion on plant lice and red spiders; and a paper on cranberry insects, with illustrations of the tip worm, the vine worm and the fruit worm. The second bulletin, No. 20, contains a brief history of the canker worms, the apple tree tent caterpillar, fall web-worm and the tussock moths, with directions for their destruction.

A Beneficial Fly.

On several occasions we have received at the insectary a long, slim, worm-like larva, found under carpets, and supposed to be injurious to woolen fabrics. This larva is about eleven-sixteenths of an inch in length, as large as an ordinary pin in the middle, and gradually tapering towards each end. The head is conical, nearly twice as long as broad, and of a reddish-brown color, while the body is whitish translucent, and together with the head comprises apparently twenty-one segments. There are a few short hairs on the head, and on each side of the three following segments. There are also a few hairs on the twentieth segment, and a pair of anal prolegs on the last segment, which is smaller and shorter than the one before it and easily overlooked.

This larva proves to be the young of a fly long known in Europe by the name of *Scenopinus fenestralis* Linn., and was redescribed in this country by Say under the name of *Scenopinus pallipes*, and by this name it was figured and described by Dr. Packard in his "Guide to the Study of Insects" (page 401). The adult fly is about one-fifth of an inch in length, metallic-black in color, with dull yellowish-brown legs and slightly gray wings.

The larva of this insect was generally supposed to feed in rotten wood, and was also thought to be destructive to carpets; but it is now known that it is carnivorous, and feeds upon other insects.

Professor Lintner reports that they feed on the larvæ of clothes moths, and this observation has also been made by others. We have lately discovered that they feed on the larvæ of the Buffalo carpet beetle, and I have one before me feeding on carpet beetles. Some time ago I kept two of the larvæ in a bottle with a piece of flannel, but both died, and I could not discover that they ate the flannel or injured it in any way. This little fly, being destructive both to clothes moths and carpet beetles, is a friend to housekeepers, and therefore should not be destroyed.

A Destructive Cut-worm.

For several years past we have received specimens of a cut-worm which has proved very injurious to the grass fields in many localities. This caterpillar is about one and three-fourths of an inch in length when full grown, and quite stout, tapering slightly from the middle towards each end. The head and top of the second segment are very dark brown, and the body of a glossy bronze-green color, with lighter longitudinal stripes. They feed by night on corn, grasses and knotweed, remaining concealed during the day under pieces of boards or in any other convenient hiding place. They pass the winter as partly grown caterpillars, and specimens bred at the insectary reached their full growth and pupated August 4, and the moths emerged September 2, of the second year.

The moth belongs to the great family *Noctuidæ*, which includes the army worm and a host of other noxious insects, and is known by the name of *Nephelodes minians* Guen. A fuller account of it will be published at some future time in one of the bulletins.

A series of experiments was conducted, during the early part of the summer, on the gypsy moth, to ascertain whether this insect can be wholly exterminated with Paris green. The proportion used in each case was one pound of Paris green to one hundred and fifty gallons of water. This was sprayed upon branches of an apple tree, and the caterpillars of the gypsy moth in their different stages of growth were placed on the leaves. From these experiments we learn that the newly hatched caterpillars can live on poisoned leaves from four to six days; just before the first molt, from one to seven days; between the first and second molts, from one to two days; between the second and third molts, from one to seven days; between the third and fourth molts, from one to twelve days; between the fourth and fifth molts, from three days to two weeks or more; or, in other words, the experiments verify the field observations on this insect in Malden, namely, that Paris green seems effective in reducing their numbers, but it does not appear that all the caterpillars on a tree can possibly be destroyed;

for in these experiments, where the leaves were sprayed more evenly and effectually than it could be done on tall trees in the field, some of the caterpillars lived long enough for all the Paris green to be washed from the leaves. All the pupæ that came from the poison-fed caterpillars were kept, and from the majority of them the moth successfully emerged, showing that, in their cases at least, they had not taken poison enough to prevent them from completing their transformations. These experiments prove beyond a doubt that we cannot rely upon Paris green for the extermination of the gypsy moth, but that other measures must be used in connection with it.

The work on the card catalogue of the literature of the insects of the United States has been pushed forward as rapidly as possible, and the final copying is about one-third done.

The biological collection has been increased by a large number of inflated caterpillars, and insects of all orders have been collected as time permitted. A similar collection has been commenced for the gypsy moth committee.

The correspondence at the insectary has grown to such proportions as to consume a large amount of time, although we have declined to answer letters on entomological matters from other States.

The Agricultural Division.

The Japanese varieties of millets which have been alluded to in previous reports have been under trial this year, both as forage and seed crops. The yield of seeds has been smaller than in previous years; viz., in the case of *Panicum italicum*, fifty-five bushels; *Panicum crus galli*, sixty-nine bushels; and *Panicum miliaceum*, twenty-eight bushels per acre. The analysis of the meal manufactured from the seed of the first shows it to resemble oats very closely in composition, and an experiment in feeding it to cows for milk in comparison with corn meal has shown it to be slightly superior to the latter for that purpose. The yield of straw is heavy, amounting to one and one-half tons per acre, and an experiment in feeding it indicates that it is even superior to corn stover for milk production. The food value of the product of an acre in millet has often exceeded the food value of an equal area of similar land in corn; but if threshed by hand the increased labor cost is out of all proportion to the excess in value. It may pay to raise the seed under favorable conditions for market, when it should be machine threshed; but as a grain crop it cannot compete with corn under the conditions existing here.

The seed of this variety was sold to a large number of farmers

in this State last spring, all of them trying it as a forage crop. Those sowing the seed in sufficient quantity and at the right time report themselves generally well pleased with the results.

Both of the other species have been tried here as forage crops, one acre of each having been grown. The yield of the two was not very different, amounting, in the case of the *miliaceum*, or "panicle" millet, to ten and three-fifths tons; while the *crus galli*, or "crow foot" millet, gave ten and one-half tons per acre. One-fourth acre of each was fed green to cows, with very satisfactory results. It would appear to be fully equal to good corn fodder, and is more closely eaten, there being absolutely no waste. The crop from three-fourths of an acre of each variety was put into a silo, which has not yet been opened. I consider these very promising fodder crops for the purposes for which we have used them, but not for making into hay, as they are too coarse for that purpose.

Three varieties of soya beans have been under cultivation. These have given yields of from about twenty-two to twenty-eight bushels per acre. It is significant that the yield has been greatest where the tubercles which are connected with the assimilation of atmospheric nitrogen were most abundant. The cause for the wide differences noticed in the number of tubercles upon the roots in different fields will be studied another season. At present we are unable to determine whether these differences were due to variety of bean, or to location; though it is believed that the fact that soya beans had previously been grown where the tubercles were this year most abundant is a sufficient explanation of the phenomena noticed, for this would mean a greater number of germs in the soil, as the certain consequence of the previous cultivation of the crop upon which the tubercle bacilli develop.

The large white Japanese radish has been under trial as a field crop. This seed is generally sold in this country under the name Chinese radish, as the Chinese as well as the Japanese make extensive use of this root as food. The crop can have no importance here for this purpose, as its flavor is too strong; but it is of possible value as a crop for cattle or sheep. It grows in about the same length of time as the larger English turnips, and gives a heavy yield. Although our seed was far from the best, we got in different fields from fifteen to twenty-two tons per acre. Sheep and cattle eat it greedily, and its food value is probably about the same as that of English turnips. It will be analyzed for the determination of this point.

Small areas of hemp and flax of several varieties have been successfully grown, but do not promise to be profitable. White

mustard gave us at the rate of twelve and one-half bushels of seed to the acre, the yield being very light, on account of injury from worms at the root while the plants were growing. This crop is under careful experiment as a nitrogen conserver and soil improver.

So-called "mammoth spring" rye offered for sale by a Connecticut seedsman proves to be utterly worthless. The seed is a mixture of wheat with a grain that has the appearance of being a hybrid between wheat and rye. The growth is very feeble and the yield exceedingly light.

A feeding experiment, designed to throw light upon the comparative value for milk production of silage and mangolds, has been carefully carried out. This experiment was tried with four new milch cows, and was continued for twelve weeks (four periods of three weeks each), with every precaution to insure reliable results. The silage was made from Longfellow corn, generally well glazed when cut. Thirty pounds of this, together with suitable amounts of hay, stover and mixed grain feed, were fed against forty pounds of sliced mangolds and equal amounts of hay, etc. The cows gave more milk and more cream when receiving silage, and gained weight, while they lost weight when receiving the beets. The figures for the four cows during eight weeks (the last two weeks only of each of the three-weeks periods being taken into account) are as follows: —

For beets: milk, 2,787 pounds; cream, 840 spaces.
For silage: milk, 2,908 pounds; cream, 849 spaces.

It will generally cost from one and one-half to two times as much to produce beets as corn silage, and the former is much the more uncertain crop of the two. The superior economy of corn for the silo over beets as a food for milk production thus becomes sufficiently evident.

As in previous years, soil tests with fertilizers in different parts of the State have engaged a large share of attention. In Bulletin No. 18 are reported the results of nine such experiments, — two with oats, five with potatoes and two with corn.

The results with corn are confirmatory of the conclusions of previous years, and indicate the great advantage of a liberal use of potash when sod land of medium fertility is broken for this crop.

For potatoes, too, the potash exerts the most marked effect upon the crop. The grand average increase for the five experiments reported is as follows: —

	Bushels.
For nitrogen: merchantable potatoes, ...	10.74
For phosphoric acid: merchantable potatoes, . .	10.11
For potash: merchantable potatoes, ...	41.55

The nitrate of soda produced a marked effect upon the oats in these experiments, and, except upon land already quite rich, its use in small amount in spring would probably be generally profitable.

The influence of fertilizer upon the quality of potatoes was studied in connection with the soil tests reported in Bulletin No. 18. A large number of chemical analyses were made for this purpose. The leading indications afforded by these analyses are: —

First. That nitrate of soda and superphosphate are favorable to starch formation and good quality;

Second. That muriate of potash is distinctly unfavorable to starch formation; and

Third That manure will produce tubers of better quality than a "complete fertilizer" in which the potash is in the form of the muriate.

Seven soil test experiments have been carried out the past season, — two with grass, three with oats, one with corn and one with soya beans. The results are not fully worked up, but the following are the leading points indicated: —

First. Potash is the controlling element for the beans and corn;

Second. Nitrate of soda is beneficial to the oats;

Third. Nitrate of soda greatly increases the yield of grass; and

Fourth. Muriate of potash causes a remarkable increase in the proportion of clover in mowings where timothy, red-top and clover seeds are sown.

The experiment of growing corn on manure alone, six cords to the acre, in comparison with corn receiving one-half as much manure and one hundred and twenty-four pounds of muriate of potash per acre, has been continued upon the same land as last year. The results are in favor of the manure alone; viz. (the average of two experiments), 60.5 bushels grain for the manure and potash, and 69.5 bushels for the manure alone. The average yields of stover are respectively 4,545 pounds and 5,207 pounds. The money cost of the manure alone was at the rate of $30 per acre; that of the manure and potash, $17.50. There is still a financial advantage (labor not included) of $5.35 in favor of the half manure and potash; but it is apparently asking too much to expect one hundred and twenty-four pounds of muriate of potash to replace three cords of manure.

A careful comparison of hill and drill culture of corn has been made, with results slightly in favor of the drill system.

The comparison of special fertilizers, as generally found in our markets, with a home mixture richer in potash, has been continued upon the same land as last year. One-half acre has been in corn,

and an equal amount in millet. There is a slight difference in favor of the special fertilizer in the case of the grain, but an equal advantage in favor of the fertilizer richer in potash in the case of the stover in the corn experiment. In the case of the millet the advantage is with the home mixture both in grain and straw. The figures are as follows: —

		Grain per Acre.	Stover per Acre.
Corn	Special fertilizer, . . .	62.3 bushels.	4,164 pounds.
	Home mixture, ...	56.7 bushels.	4,452 pounds.
Millet	Special fertilizer, . . .	54.3 bushels.	2,700 pounds.
	Home mixture, . . .	56.3 bushels.	3,050 pounds.

The materials in the special fertilizer cost at the rate of $13.66 per acre; those in the home mixture, $10.70.

Two experiments have been tried for the comparison of the sulphate with the muriate as a source of the potash in fertilizer for potatoes. In one experiment all the fertilizers were applied broadcast, in the other they were broadly scattered in the drill. In both experiments the results were decidedly in favor of the sulphate. The yields per acre were as follows: —

Sulphate of Potash.

Broadcast, merchantable tubers, 185.7 bushels; small tubers, 10.8 bushels.

Drill, merchantable tubers, 192.5 bushels; small tubers, 13.5 bushels.

Muriate of Potash.

Broadcast, merchantable tubers, 166.6 bushels; small tubers, 13.3 bushels.

Drill, merchantable tubers, 179.1 bushels; small tubers, 17.0 bushels.

In these experiments the fertilizers were used in such quantities as to supply equal amounts of actual potash in each plat, and together with the potash salts were used suitable amounts of fertilizers supplying nitrogen and phosphoric acid, the same to each plat.

In appearance when cooked, and in eating quality, the potatoes grown upon the sulphate of potash were distinctly and decidedly better than were those grown upon the muriate. This statement is

made upon the independent authority of three parties who tested them repeatedly, and without knowing in any case the nature of the difference between the samples offered for the test.

Experiments with grass in half and quarter acre plats have been carried out during the last three years in great number. In these experiments the plan has been to study the question whether manure at the local prices, or fertilizers, would afford the more profitable increase in crop. Manures of various kinds have been used on from seven to ten plats each year, and in quantities varying from about three to five cords per acre. Fertilizers in various combinations and amounts have been employed upon about an equal number of plats. The materials used have been muriate of potash, dry ground fish, dried blood, bone meal and superphosphate. Among the most satisfactory combinations have been: —

1. Muriate of potash, 160 pounds; dry ground fish, 400 pounds.
2. Muriate of potash, 160 pounds; dry ground fish, 200 pounds; and bone meal, 200 pounds.

In these experiments the manure applied has cost on the land from $15 to $25 per acre. The increase in the crop has been insufficient to repay this expenditure. Such applications of fertilizers as I have mentioned above can be made for $10 to $12 per acre, and the increase in crop is sufficient to repay such an expenditure.

The Horticultural Division.

The work of this division has been continued on similar lines to those of former years, and is outlined as follows: —

Comparison of New and Old Varieties of Fruits.

Among the new varieties of fruits tested, few if any have been found superior or even equal to the older sorts. Many of them are very promising, but their real value for New England can only be determined by several years' tests, and that in more than one locality.

Taking the old and new varieties together, those that our tests lead us to pronounce the most valuable for general market and home use are as follows, given in the order of ripening: —

Apples. — Red Astrachan, Gravenstein, Haas Baldwin, Rhode Island Greening, Roxbury Russett.

Pears. — Giffard, Clapp, Bartlett, Bosc, Sheldon, Anjou, Lawrence, Dana's Hovey.

Peaches. — Amsden (on account of hardiness of buds), Early Rivers, Crawford's Early, Crawford's Late, Mountain Rose, Oldmixon, Crosby (Excelsior) and Stump.

Plums. — Bradshaw, McLaughlin, Lombard, German Prune.

Quinces. — Orange and Rea's Mammoth.

Grapes. — Moore's Early, Worden, Concord, Delaware, Winchell (Green Mountain).

Blackberries. — Agawam, Snyder, Taylor's, Erie.

Black-cap Raspberries. — Souhegan or Doolittle, Gregg, Nemeha, Crawford.

Red Raspberries. — Marlborough, Hansell, Cuthbert.

Currants. — Versaillaise, Cherry and Fay's Prolific.

Strawberries. — Beder Wood, Bubach, Haverland, Sharpless.

Fungicides, and Insecticides and Fungicides combined.

Fungous diseases, owing to the dryness of the season, have not been as prevalent the past as in several preceding seasons, but marked results were obtained in many experiments. By combining the Bordeaux mixture with Paris green, the apple scab and the codling moth were largely destroyed, as was also the potato beetle and potato blight or rot.

The plum wart was largely prevented by the application of kerosene, by the use of copper solutions, and the severe heading in of the infected trees.

The black or Italian poplar, so badly injured by the poplar rust for two seasons past, was treated with many kinds of fungicides, and from the results obtained this season we believe this alarming disease can be controlled.

The carnation rust, reported in many greenhouses as causing much injury, has been treated with the Bordeaux mixture and other fungicides, with very favorable results.

The use of the simple solutions of copper sulphate suggested in our April bulletin has not been as satisfactory as was anticipated, the foliage of nearly all kinds of trees and plants having, under some circumstances, been injured by it.

Experiments in overhead *vs.* underbench piping have been continued with about the same results as for the past two years.

Fertilizers for the greenhouse have been experimented with, but no results have been reached at this time, other than those reported in previous bulletins.

Spraying Apparatus.

Many kinds of spraying pumps have been tested, as well as nozzles and other appliances, and also numerous kinds of fungicides and insecticides, both out doors and under glass; but we find

the best results thus far obtained from the Bordeaux mixture and ammoniacal carbonate of copper as a fungicide, and Paris green as an insecticide.

The Meteorological Division.

The line of work previously decided upon in this division has not been fully performed. The series of experiments in electro-culture, pursued for a season with encouraging results, has been delayed; the necessary apparatus has been purchased and preparations made, and it is hoped that when the season opens investigation in this direction may be resumed. In other respects there has been steady progress toward improvement. A fine standard signal service barometer for verifying the readings of the barograph, and Greeley's "self-starting, self-stopping, ink-writing telegraph register," have been placed in the observatory. The latter instrument is unique in itself, and designed to record weather forecasts which at any time may be telegraphed to the college. The connection, however, between the observatory and the main line has not been made; but as soon as this can be accomplished and preparations for displaying flags completed, the weather service at Washington will furnish the daily forecasts free.

For taking observations at the base of the tower there have been recently purchased a new set of maximum and minimum thermometers, a portable self-registering anemometer, and Furgesson's self-recording rain and snow gauge. This new apparatus, in addition to the valuable appliances already in place, increases the value of the division, and makes an observatory more fully equipped with self-recording instruments than any other of its kind in the country. With the present facilities for work, and encouraging prospects ahead, it is hoped that soon the object so long pursued and the efforts put forth will be realized and appreciated in a well-established signal station at the college.

A knowledge of the climate is of vital importance to the agriculturist; extreme periods of heat and cold, early and late frosts, rainfall and drought, relative humidity, and the ever-changing conditions of the weather, hold largely in their power the success and failure of crops and the health and prosperity of the people. As every locality has a climate peculiar to itself, it is wise that the meteorology of each section of country should be thoroughly understood. It is with this end in view that the department has undertaken to study the large amount of most valuable meteorological data, collected for the last fifty-seven years by the late Professor Snell (of Amherst College) and the Misses Snell, and bring it into a more condensed form, that deductions can be made and some definite conclusion drawn as to the mean climate of Amherst.

Much credit is due Miss Sabra Snell, who kindly allowed the writer the use of the valuable records in her charge, which greatly aided him in arriving at the results herewith submitted. The data mostly reviewed are those relating to atmospheric pressure, temperature and precipitation in the form of rain and snow. Accompanying these results will be found a chart upon which curves are traced, showing the fluctuations of the mean yearly barometric pressure, mean annual temperature, mean temperatures of the summer and winter months, and the rain and snow fall for the last fifty-seven and fifty-two years respectively.

Atmospheric Pressure.

From what has been observed and recorded, we deem it safe to say that the mean barometric pressure at Amherst (reduced) is seldom if ever greater than 29.81 inches, or less than 29.66, the difference being .15 of an inch. It is found that during fifty-six years the mean barometer has fallen below 29.70 only nine times, while it has reached 29.70, or above that point, forty-seven times.

It is also noticed that the first mean recorded was 29.68; fifteen years elapsed before the mean again fell below 29.70; three years intervened, when the mean was again below 29.70; two years later the same occurred, making the cycle of five years complete; two periods of five years passed, and at the end of each the mean fell below 29.70; then came a break of three years, after which another period of five years and a minimum below 29.70, the latter always occurring on the fifth year or the one following. Fourteen years have elapsed since the last minimum below 29.70 was recorded. Thus from the facts above noted it would seem that the minimum pressures, with few exceptions, occur in cycles, and that the number of years in these cycles is some multiple, or very near some multiple, of five. Basing the value of future expectations on deductions already made, we find the probability that the mean pressure in inches for each of the next fifty-six years will be —

At least as high as	29.70	to be as	47 : 9
At least as high as	29.72	to be as	45 : 11
At least as high as	29.74	to be as	33 : 23
At least as high as	29 :76	to be as	22 : 34
At least as high as	29.77	to be as	12 : 44
At least as high as	29.78	to be as	7 : 49
Above . . .	29.78	to be as	4 : 52

Temperature.

In 1836 the mean temperature was 52.70°, and fifty-two years after the mean was 50.88°. The number of years between these

two dates is very close to a multiple of six. If we consider the next lowest maximum, 49.81°, which occurred in 1839, we find that thirty years afterward the mean again reached above 49°, namely, 49.17°. Then a period of six years intervened, and a mean temperature above 49° was recorded for two years in succession, the true means being 49.12° and 49.47° respectively. Reckoning from the first of these maxima, we find that just twelve years elapsed, when the mean temperature was again above 49°, namely, 50.88°. If we count from the last maximum, we find twelve years intervened before the same mean was again recorded. Hence it would seem that the mean temperature from 49° upward occurred in periods of some multiple, or very near some multiple, of six.

If we consider the next lowest maximum, viz., 48.85°, we find that the latter occurred in 1841; four years elapsed, when a yearly mean of 48.02° was recorded. Twenty-four years later the 48° line was crossed, for the mean temperature was 49.17°. The seventh and eighth years following, the temperature passed the maximum line in question; reckoning from the first of these, the seventh, we find four years later another mean of 48.49°; reckoning from the second or eighth year, we find in just four years yet another mean of 48.70° recorded; that is, two years in succession the mean temperature was over 48° but less than 49°. Taking the first of these as our starting point, we find that four years intervened, and the mean temperature of 48.29° occurred; another four years passed, and the maximum line was again crossed by the mean of 50°.

It would seem, therefore, from the above statements, that the occurrence of a mean temperature of at least 48° appeared in cycles whose number of years is some multiple of four, with an occasional exception. As the yearly means approach the mean for fifty-seven years, that is, 47°, the maximum and minimum points in the curve occur more irregularly. The numbers forty-five, forty-six and forty-seven, the integral parts of three means, occur forty-one times; that is, the number forty-five appears eight times, the number forty-six twenty-four times, the number forty-seven nine times, and there have been thirty-six years during the period under discussion when the mean yearly temperature was below 47°.

On examining the curve which indicates the mean temperatures for the winter months during fifty-six years, it will be noticed that the maximum means occur in cycles, the number of years in each being some multiple, or very near some multiple, of five. If the four lowest minima are considered, it will be found that from the first minimum to the second, fifteen years had passed; thirteen

years after another minimum occurred, and twenty years later the fourth minimum was registered.

It would seem, then, that the periods between the ocurrences of low temperatures are also multiples, or near some multiple, of five. Again, the mean temperature of the summer months recorded as being above 70° with one exception occur in periods, the number of years in each being some multiple, or near some multiple, of five. The following is a table of probabilities based on the yearly mean temperature for the last fifty-seven years. The expectation that the mean annual temperature for the next fifty-seven years will be —

At least	52 degrees	is as	1 : 56
At least	50 degrees	is as	2 : 55
At least	49 degrees	is as	7 : 50
At least	48 degrees	is as	12 : 45
At least	47 degrees	is as	21 : 36
At least	46 degrees	is as	45 : 12
At least	45 degrees	is as	53 : 4
At least	44 degrees	is as	56 : 1
At least	43 degrees	is as	57 : 0

There is no probability that the mean yearly temperature will be below 43° during the next fifty-seven years.

Precipitation.

Regarding the rain, it is found that in 1843 the mean rainfall was 51.58 inches; in 1850, 55.05 inches was noted; in 1853, ten years from the time the first mean above 50 inches was observed, 51.23 inches of water fell; five years elapsed, then a mean of 51.28 inches occurred; four years later, in 1863, 57.71 inches of rain fell; six years later, 53.29 inches, — and thus another cycle of ten years was completed. It would thus seem that the mean annual rainfall of 50 or more inches occurs in periods, the number of years in each period being some multiple of five. But if we consider the three largest yearly means, it will be seen that they occur in cycles of some multiple of twelve. For example, in 1850, as stated above, 55.05 inches of rain were registered; twelve years after, 57.71 inches were recorded; and twenty-four years later, 58.04 inches were observed.

The probability that the mean rainfall for each of the following fifty-seven years —

Will be at least	58 inches	is as	1 : 56
Will be at least	57 inches	is as	2 : 55
Will be at least	55 inches	is as	3 : 54
Will be at least	53 inches	is as	4 : 53

Will be at least	51 inches	is as	7 : 50
Will be at least	50 inches	is as	8 : 49
Will be at least	49 inches	is as	10 : 47
Will be at least	48 inches	is as	13 : 44
Will be at least	47 inches	is as	17 : 40
Will be at least	46 inches	is as	21 : 36
Will be at least	45 inches	is as	23 : 34
Will be at least	44 inches	is as	25 : 32
Will be at least	43 inches	is as	28 : 29
Will be at least	42 inches	is as	34 : 23
Will be at least	41 inches	is as	39 : 18
Will be at least	40 inches	is as	43 : 14
Will be at least	39 inches	is as	47 : 10
Will be at least	38 inches	is as	52 : 5
Will be at least	37 inches	is as	53 : 4
Will be at least	36 inches	is as	54 : 3
Will be at least	35 inches	is as	54 : 3
Will be at least	34 inches	is as	56 : 1
Will be at least	30 inches	is as	57 : 0

There is no probability that the mean yearly rainfall will be less than 30 inches for the next fifty-seven years. The mean rainfall from 1836–92 inclusive is 44.05 inches, and twenty-five of the years during this period had a mean rainfall of 44 or more inches, while thirty-two years had a mean below 44 inches. Therefore the probability that the mean yearly precipitation for the next period of fifty-seven years will be equal to the mean of the last fifty-seven years, is as 25 : 32.

Snowfall.

It is found that the mean snowfall varies greatly from year to year. During the last fifty-two years the annual depth has ranged from 17 to 87 inches. The whole amount recorded is 230.42 feet, or an average of 53.17 inches per year. The curve shows that very seldom does the same depth occur twice during this period. Twenty-seven times the yearly mean was 52 or more inches, and twenty-five times below 52. That is, the probability that at least 52 inches of snow may fall each of the next fifty-two years is as 27 : 25. If the time be divided into three periods, beginning with 1840, it is found that the first seventeen years 923.7 inches of snow, or an average of 54.33 inches per year, was recorded; the second period of seventeen years, 951.5 inches, or an average of 55.9 inches each year; while the last eighteen years the whole amount is 889.9 inches, or a yearly mean of 49.44 inches. This would seem that for the last eighteen years the mean yearly snowfall had gradually decreased.

Recapitulation.

Mean barometric pressure, in inches, 1837–92,	29.741
Mean temperature, June, July and August, 1836–62,	68.26° F.
Mean temperature, June, July and August, 1862-92,	68.10° F.
Mean temperature, December, January and February, 1836–62,	24.53° F.
Mean temperature, December, January and February, 1862–92,	28.25° F.
Mean temperature, 1st period of 19 years, 1835-54,	47.29° F.
Mean temperature, 2d period of 19 years, 1854–73,	46.48° F.
Mean temperature, 3d period of 19 years, 1873-92,	47.23° F.
Mean yearly temperature, 1836–92,	47.00° F.
Greatest annual rainfall, 1888,	58.04 inches.
Least annual rainfall, 1837,	30.70 inches.
Mean annual rainfall, 1836-92,	44.05 inches.
Amount of snow, 1840–57, 923.7 inches; yearly average,	54.33 inches.
Amount of snow, 1857–74, 915.5 inches; yearly average,	55.90 inches.
Amount of snow, 1874–92, 889.9 inches; yearly average,	49.44 inches.
Amount of snow, 1840-92,	230.42 feet.
Average per year,	53.17 inches.
Greatest depth recorded, 1875,	87.5 inches.
Least depth recorded, 1877,	17 inches.
Mean cloudiness observed, 1845-92,	50.83 per ct.

Since Jan. 1, 1892, a careful record of the daily forecasts, both Washington and local, has been kept; each day these forecasts have been compared with the true state of the weather at Amherst, and the percentages of correctness recorded and remarks made upon those predictions that have proven failures or partial failures. This feature of our work was desired, in order that a better knowledge of the efficiency of the weather service might be obtained.

The following table gives the percentages of forecasts which were found to be correct for Amherst: —

	* Local Forecast.	Washington Forecast.
1892.	Per Cent.	Per Cent.
January,	93.3	87.
February,	93.1	86.6
March,	100.	100.
April,	93.3	80.
May,	80.6	71.
June,	70.	83.3
July,	88.8	87.
August,	96.7	96.7
September,	96.3	96.6
October,	93.6	96.8
November,	96.6	96.6
December,	90.5	88.9
Total average for the year,	91.06	89.2
Difference in favor of local,	1.86 per cent.	

* The term "local" indicates Boston forecasts.

EXPLANATION OF PLATES.

Fig. 1. — Represents mean yearly barometric pressure at Amherst, 1837–92.

2. — Represents mean temperature of June, July and August, 1836–92.

3. — Represents mean temperature of December, January and February, 1836–92.

4. — Represents mean yearly temperature, 1837–92.

5. — Represents mean snowfall, in feet, 1840–92.

6. — Represents mean rainfall, in inches, 1836–92.

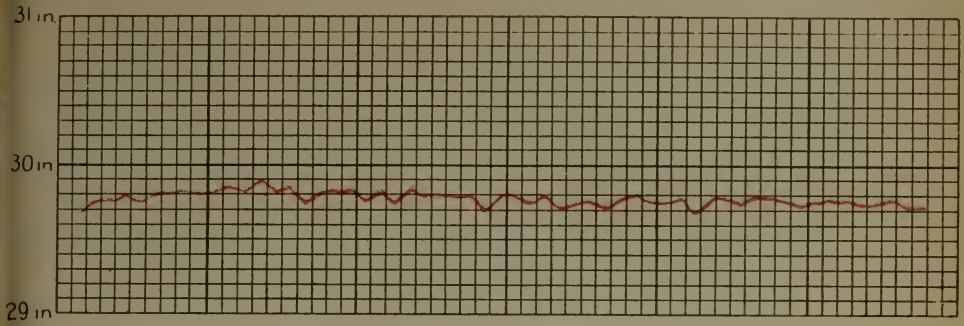

Fig. 1. Mean barometric pressure. 1837-1892

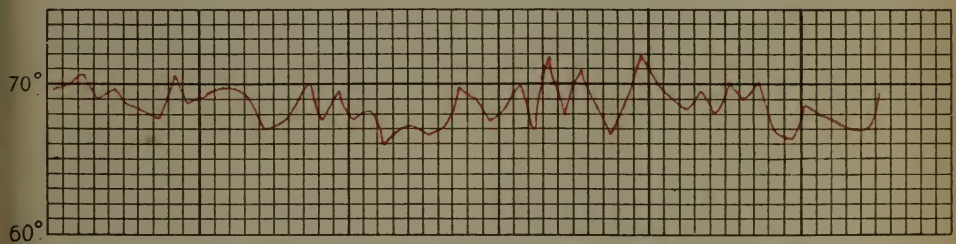

Fig. 2. Mean temperature summer months. 1836-1892.

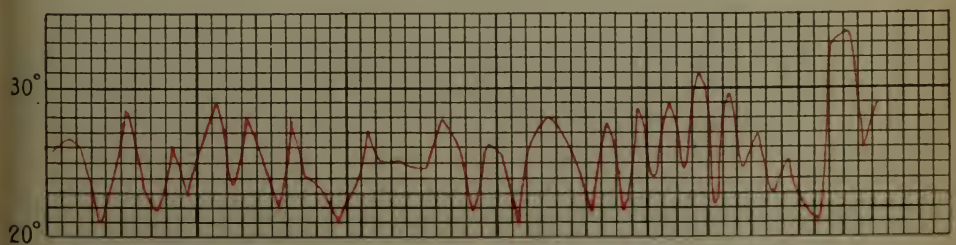

Fig. 3. Mean temperature winter months. 1836-1892

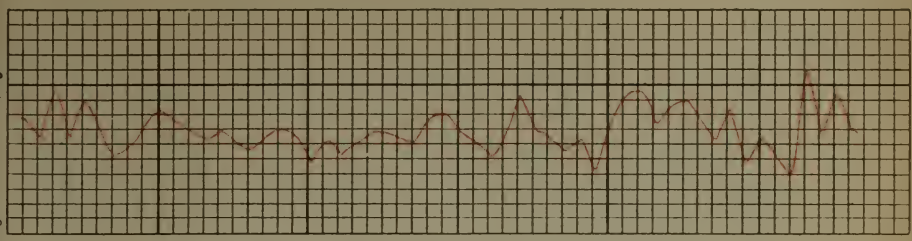

Fig. 4. Mean yearly temperature. 1836 - 1892

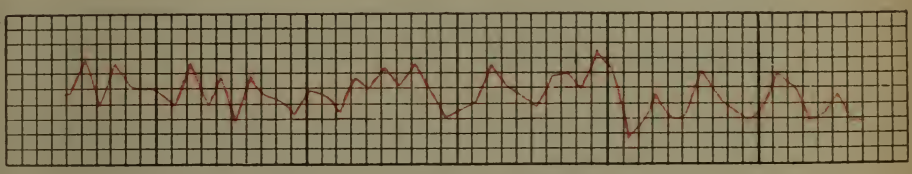

Fig. 5. Snowfall in feet. 1840 - 1892.

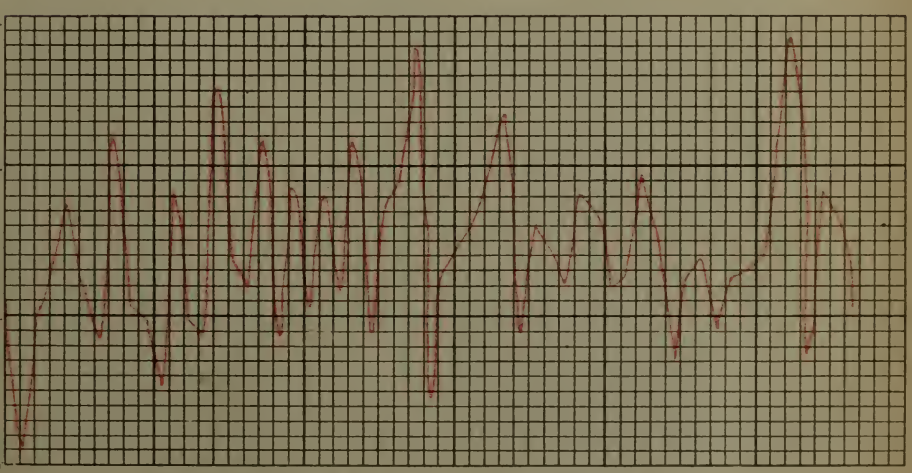

Fig 6. Rainfall in inches. 1836 - 1892.

Relation of Climate to Health.

The relation of climate to health and disease is attracting the attention of scientific minds. Large numbers of statistics are being collected for the purpose of discovering the exact bearing that temperature, relative humidity and different electrical conditions of the atmosphere have upon the health and mortality of the people. That a direct relation exists, all who have investigated the subject admit. Much time has been spent by this division in collecting and comparing statistics, with a view of aiding in this important undertaking. While the work has not progressed sufficiently to warrant a lengthy article on the subject, still we deem it proper to present at this time a few summary results.

The curve of mortality has an inverse relation to temperature. In some climates, however, the curve of mortality and temperature are directly related, rising and falling together.

Fevers seem to be related to high temperature, and generally follow it.

The absolute humidity curve almost always follows that of cholera infantum and cholera morbus.

Pneumonia and diphtheria, small-pox, scarlet-fever and consumption, invariably increase as the temperature falls.

"La Grippe" is thought to be the direct result of natural atmospheric conditions, chiefly a high followed by a sudden change to low temperature.

From careful observation it seems that there is a close connection between ozone at low temperature and deaths from pneumonia. The ozone and cholera curves are inverse to each other, as also the ozone and intermittent fever curves.

TREASURER'S REPORT.

ANNUAL STATEMENT OF THE HATCH FUND.

For the Year ending June 30, 1892.

BY GEORGE F. MILLS, Treasurer *pro tem.*

Cash received from the United States,		$15,000 00
from agricultural department,		76 11
from chemical department,		27 78
		$15,103 89
Cash paid, salaries,	$7,914 13	
library,	140 62	
labor,	1,618 59	
freight and express,	71 29	
printing,	1,790 98	
incidentals,	947 34	
supplies,	1,915 26	
general fittings,	301 33	
chemical apparatus,	285 07	
postage,	52 09	
travelling expenses,	67 19	
		$15,103 89

AMHERST, MASS., July 28, 1892.

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1892, and have found the same well kept and correctly classified as above, and that the receipts for time named are shown to be $15,103.89, and the corresponding disbursements $15,103.89. All of the proper vouchers are on file, and have been by me examined and found correct, there being no balance to be accounted for in the fiscal year ending June 30, 1892.

J. H. DEMOND, *Auditor.*

Cash received on insurance fund, Hatch Agricultural building,		$1,845 37
Cash received for interest,		21 47
		$1,866 84
Cash paid for rebuilding,	$1,866 84	

JULY 28, 1892.

This is to certify that I have this day examined the accounts of cash received and paid in money received for insurance on Hatch agricultural building, and find that the sum of $1,866.84 has been expended, that the proper vouchers are on file, and that there is no balance to be accounted for. J. H. DEMOND, *Auditor.*

I hereby certify that the foregoing is a true copy from the books of account of the Hatch Experiment Station of the Massachusetts Agricultural College. GEORGE F. MILLS, *Treasurer pro tem.*

I hereby certify that George F. Mills is the treasurer *pro tem* of the Massachusetts Agricultural College, and that the above is his signature.

[SEAL.] HENRY H. GOODELL,
President Massachusetts Agricultural College.

Equipment.

Large additions have been made during the year to the equipment of every department. Twenty thousand dollars have been made available for this purpose under the recent grant of Congress, entitled the Morrill act. The veterinary department has been thoroughly equipped with working models of the horse, and the principal parts of the body, as the head, leg, uterus, jaws and teeth. A small laboratory has been likewise fitted up with microscope, culture ovens and sterilizers for the study of germ diseases. In the zoölogical department has been placed a fine collection of mounted animals, clastic models, diagrams and charts, showing the operations of life throughout the entire animal kingdom. This is intended to illustrate particularly the difference in structure of the various organs of the body, and their uses. The chemical department has received an entirely new outfit, and that of physics has been equipped with apparatus necessary for the study of electricity. To the library large additions have been made, particularly in the departments of political economy, agriculture, zoölogy and chemistry. In the agricultural department a beginning has been made of an economic museum, and implements and apparatus of all kinds have been collected, in the effort to represent a history of agricultural machinery. A collection of soils has been made, and samples are being gathered of all the artificial and commercial fertilizers used in the State. A museum of the kind contemplated, bringing together under one roof everything bearing upon agriculture and its history and progress, demands a building specially constructed and adapted to its purpose, in which shall be combined the museums of the departments of agriculture, zoölogy and veterinary science, and in which space shall be found for lecture rooms and laboratories. This must be included in the immediate wants of the college.

The Labor Fund.

This fund was established by the Legislature in 1888. Its object is to assist worthy young men of limited means to procure an education by furnishing them work, for which a

reasonable compensation is paid. Since its establishment over one hundred and fifty young men have been aided, and twenty thousand dollars have been paid out for work which has been in the direct line of their studies, and which has at the same time materially contributed to the improvement of the college grounds. Among other improvements may be mentioned the laying of nine or ten miles of drain pipe, and the undertaking of work in the horticultural department made possible only by this wise provision of the General Court. With numbers that have increased forty-five per cent. since the creation of the fund, this appropriation of five thousand dollars per annum proves entirely inadequate. Applications for work exceed the supply, and already students have been compelled to leave for lack of the very work which alone enabled them to stay and complete their education. Can the great State of Massachusetts, a State which has always led the way in all questions of education, afford to continue this policy? The great demand to-day is for educated men. Is not this the cheapest way in which she can supply it, — by increasing this gift, which makes a direct return to her in the enhanced value of her property, and a still greater return in the education of her sons into a more perfect manhood.

Course of Study.

The increased endowment of the college, under the provisions of an act of Congress, Public, No. 249, approved Aug. 30, 1890, and entitled, "An Act to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts, established under the provisions of an act of Congress, approved July 2, 1862," makes it possible to raise the standard of admission and offer additional courses. The trustees therefore recommend to His Excellency the Governor and honorable Council the adoption of the following outline of study: —

First. The establishment of three courses of study, to wit: (*a*) A two years' course, leading to a simple diploma. This is intended for those of limited means, unable to take

the full course, but who desire to secure a certain amount of practical instruction bearing upon the work of the farm and the garden. It is also intended as a preparation for those wishing to enter the longer course. (*b*) A four years' course, leading to the degree of Bachelor of Science. (*c*) A graduate course of two years, leading to the degree of Master of Science.

Second. (*a*) The requirements for entrance to the two years' course shall be English grammar, geography, arithmetic and history of the United States; the age, fifteen years. (*b*) The requirements for entrance to the four years' course shall be English grammar, geography, history of the United States, arithmetic, algebra through quadratics, geometry (two books), physical geography, physiology, civil government and Latin (the grammar and ten chapters of the first book of Cæsar); age, sixteen years. (*c*) Candidates for the degree of Master of Science in the graduate course must have first received that of Bachelor of Science, or its equivalent.

Third. Making elective the studies of senior year in the full course, with the exception of English and military science.

Fourth. Adding to the courses as already laid down those of electricity, forestry, cryptogamic botany, entomology and German.

To provide for giving instruction in these several courses, sensible additions must be made to the teaching force. This will be possible by the increased endowment of the maintenance fund of the college granted by Congressional action, and which by a wise provision can only be spent in instruction and supplying facilities therefor.

Course of Home Reading.

The increase in the number of various associations among the farmers of the State has created a demand for a list of good books for home reading, on the subjects of agriculture, botany, horticulture, entomology and political science, — books adapted to the taste and ability of the average reader, whose time and strength are limited, and yet who wishes to fit himself to understand and to participate in such discus-

sions as arise from time to time on topics of great importance to success in his chosen occupations. In response to this demand the following courses of reading are recommended.

Agriculture: —
Morrow and Hunt, Soils and Crops.
Chamberlain, Practical Drainage.
Warrington, The Chemistry of the Farm.
Masters, Plant Life on the Farm.
Harris, Talks on Manures.
Gregory, Fertilizers.

Live Stock and Dairy: —
Curtis, Horses, Cattle, Sheep and Swine.
Sanders, Horse Breeding.
Flint, Milch Cows and Dairy Farming.
Stewart, Dairyman's Manual.
Wallace, Farm Live Stock.

Botany: —
Wood, Fourteen Weeks in Botany.
Newell, Reader in Botany.
Bailey, Talks Afield.

Horticulture: —
Fuller, Small Fruit Culture.
Maynard, Practical Fruit Grower.

Market Gardening: —
Henderson, Gardening for Profit.
Greiner, How to make the Garden pay.

Entomology: —
Weed, Insects and Insecticides.
Treat, Injurious Insects of Farm and Garden.

Political Economy: —
Ely, Political Economy (Chautauqua series).
Walker, Political Economy (briefer course).

Meteorology: —
Johnson, Sunshine.
Lewis, Air and Water.

Sewage.

The sewage from the college dormitories has never been properly cared for. When the south dormitory was erected, the money appropriated by the State having been exhausted, the sewage was simply conveyed to a point but a few hundred feet distant, and allowed to discharge into a ravine.

Aside from the folly of wasting so much excellent fertilizer. material, there is the danger, increasing each year, of the ravine becoming a hot-bed of disease, and spreading contagion and sickness among the students. The present outlet of the town sewer is so near the southern boundary of the farm as to threaten to become a nuisance. For the sake of securing a means of illustrating to our students and the people of the State the advantages of this method of disposal and utilization of sewage, we ask for an appropriation for the purpose of constructing settling tanks, flushing basins, filter beds, etc., and purchasing the proper drainage pipes, siphons and gates. Considerations of health, economy and education alike demand this.

Gifts.

From estate of T. O. H. P. Burnham of Boston, a legacy of five thousand dollars.

The class of 1892, a tower clock.

Mr. J. Howe Demond of Northampton, a bell and striking apparatus.

J. M. Sears, Esq., of Boston, a pair of Tamworth pigs.

Mr. James Draper of Worcester, a No. 1 imperial lawn vase.

The Walter A. Wood Company of Hoosick Falls, N. Y., a tubular steel mower.

Syracuse Chilled Plough Company of Syracuse, N. Y., ten ploughs, two cultivators, one harrow.

E. L. Hill of West Upton, a milk ærator.

The Champion Milk Cooler Company of Cortland, N. Y., a champion milk cooler.

The Western Alumni Association, rhetorical prizes for 1893.

C. D. Warner (M. A. C., '81) of Amherst, mathematical prize for 1893.

Lieut. John Bigelow of the United States Army, "Principles of strategy."

Chas. F. Smith of Amherst, thirteen volumes State documents.

Fred. Boettger of Peoria, Ill., Flora Peoriana.

Edgar H. Libby (M. A. C., '74) of New York City, two volumes miscellaneous.

From Hon. Fredk. S. Coolidge of Ashburnham, nine volumes government documents.

Chas. H. Fernald of Amherst, "List of Lepidoptera of boreal America."

Chas. H. Plumb (M. A. C., '82) of Lafayette, Ind., four volumes miscellaneous.

Hon. Jos. E. Pond of North Attleborough, eight volumes bee journals.

L. A. Goodman of Westport, Mo., seven volumes "Transactions of Missouri Horticultural Society."

Maj. Henry E. Alvord of Washington, D. C., "Butter tests of registered Jersey cows."

Hon. Chas. Whitehead of London, Eng., "Methods of preventing attacks of insects and fungi; diamond-back moth caterpillar."

Dr. T. Mitchell Prudden of New York City, "Study on the action of dead bacteria, in the living body; study of experimental pneumonitis in the rabbit; drinking water and ice supplies."

Carpenter & Morehouse, bound volume of "Amherst Record," 1891.

Mr. H. Heaton of Amherst, four volumes "Battles and leaders of the civil war."

Robert Warington of England, "Occasional papers on agricultural chemistry."

Austin Peters (M. A. C., '81) of Boston, "Rabies: its prevalence and suppression."

Miss Eleanor A. Ormerod of Spring Grove, England, "Observations of injurious insects."

Hon. Jas. S. Grinnell of Greenfield, "History of sheep husbandry in Massachusetts."

Dr. Daniel Draper of New York City, "Report of New York Meteorological Observatory, 1892."

Hon. Francis H. Appleton of Lynnfield, "Centennial year of Massachusetts Society for Promoting Agriculture."

James E. Humphrey of Amherst, "Amherst trees."

Thos. B. Wales of Boston, ten volumes of Holstein-Friesian herd book.

John F. Winchester (M. A. C., '75) of Lawrence, "Strongylus armatus."

Ed. Norton of Farmington, Conn., third volume of "Herd Register of American Guernsey Cattle."

Royal Society of Canada, eighth and ninth volumes of "Transactions."

Also the following papers and periodicals from the publishers: "The Massachusetts Ploughman," "The American Cultivator," "The New England Farmer," "The American Veterinary Review," "The American Garden," "The Poultry Monthly," "The Mirror and Farmer," "The American Grange Bulletin," "The Farm and Home," "The Berkshire Courier," "The Home Farm," "The Ohio Practical Farmer," "The Orange Judd Farmer," "The New England Homestead," "The Swine Breeder's Journal."

In conclusion, briefly summing up the immediate necessities of the college, we find them to be: new accommodations in the chemical department, disposal of sewage, new barn, dairy, ice house and removal of old farm buildings.

Respectfully submitted,

HENRY H. GOODELL,
President.

TREASURER'S REPORT.

GEORGE F. MILLS, *Treasurer pro tem. of Massachusetts Agricultural College, for the Year ending Dec. 31, 1892.*

	Received.	Paid.
Cash on hand,	$2,986 99	–
Term bill,	5,802 95	$1,595 31
Botanical,	4,813 92	5,474 82
Farm,	4,828 71	7,800 40
Expensè,	427 10	8,079 10
Laboratory,	999 63	443 87
Salary,	225 00	12,383 55
Library fund,	341 96	341 96
Endowment fund,	11,425 87	–
State scholarship fund,	15,000 00	–
Hills fund,	8,658 86	8,480 08
Grinnell prize fund,	52 50	40 00
Whiting Street fund,	51 15	160 00
Mary Robinson fund,	868 14	880 00
Gassett fund,	42 94	–
Extra instruction,	43 50	343 50
Labor fund,	5,018 00	6,465 92
Insurance,	–	159 66
Reading room,	–	134 05
Advertising,	–	241 69
Special appropriation, Bangs property,	–	2,525 00
Special appropriation, dam,	–	995 91
Cash on hand Dec. 31, 1892,	–	5,042 32
	$61,587 22	$61,587 22

CASH BALANCE, AS SHOWN BY THE TREASURER'S STATEMENT, BELONGS TO THE FOLLOWING ACCOUNTS.

Grinnell prize fund,	$32 50
Mary Robinson fund,	176 32
Hills fund,	196 31
Whiting Street fund,	54 91
Gassett fund,	44 70
General fund of college,	4,537 58
	$5,042 32

Cash and Bills Receivable Dec. 31, 1892.

Farm,	$500 45
Term bills,	596 66
Laboratory,	192 63
Botanical,	877 71
Labor fund,	1,313 36
Cash on hand of general fund,	4,537 58
	$8,018 39

Bills Payable Dec. 31, 1892.

Expense,	$21 41
Farm,	1,305 62
Labor fund,	86 76
Term bill account,	134 80
	$1,548 59

Value of Real Estate.

Land.

	Cost.	
College farm,	$37,000 00	
Pelham quarry,	500 00	
Bangs property,	2,525 00	
		$40,025 00

Buildings.

	Cost.	
Laboratory,	$10,360 00	
Botanic museum,	5,180 00	
Botanic barn,	1,500 00	
Durfee plant house and fixtures,	12,000 00	
Small plant house and fixtures,	3,000 00	
Tool house,	2,000 00	
North college,	36,000 00	
Boarding-house,	8,000 00	
South dormitory,	37,000 00	
Graves house and barn,	8,000 00	
Farm house,	4,000 00	
Farm barns and sheds,	14,500 00	
Stone chapel,	31,000 00	
Drill hall,	6,500 00	
President's house,	11,500 00	
Four dwelling-houses and shed purchased with farm,	10,000 00	
		200,540 00
		$240,565 00

Inventory of Personal Property.

Botanical department,	$9,672 05
Farm,	17,723 50
Laboratory,	2,777 00
Natural history collection,	4,388 79
Veterinary department,	1,443 39
Agricultural department,	1,290 00
Physics,	3,587 26
Library,	12,000 00
Fire apparatus,	500 00
Boarding-house,	350 00
Books and furniture in treasurer's office,	479 74
	$54,211 73

Summary Statement.

Assets.

Total value real estate, per inventory,	$240,565 00
Total value personal property, per inventory,	54,211 73
Total cash on hand and bills receivable, per inventory,	8,018 39
	$302,795 12

Liabilities.

Bills payable, as per inventory,	1,548 59
	$301,246 53

Funds for Maintenance of College.

Technical educational fund, United States grant, amount,	$219,000 00	
Technical educational fund, State grant,	141,575 35	
By law two-thirds of the income is paid to the treasurer of the college, and one-third to Institute of Technology. Amount received in 1892,		$11,425 87
State scholarship fund, $10,000. This sum was appropriated by the Legislature in 1886, and is paid in quarterly payments to the college treasurer,		10,000 00
Hills fund of $8,542 in hands of the college treasurer. This was given by Messrs. L. M. and H. F. Hills of Amherst. By the conditions of the gift the income is to be used for the maintenance of a botanic garden. Income in 1892,		478 86
Annual State appropriation of $10,000. This sum was appropriated by the Legislature of 1889, for four years, for the endowment of additional chairs and for general expense. Five thousand dollars of the sum was appropriated as Labor Fund, to provide for payment for labor performed by needy and worthy students. The Legislature of 1892 continued the appropriation for another four years,		10,000 00
Amount carried forward,		$31,904 73

Amount brought forward, ...	$31,904 73
Grinnell prize fund of $1,000, in hands of college treasurer. Gift of Ex-Gov. William Claflin, and called Grinnell Fund in honor of his friend. The income is appropriated for two prizes, to be given to the two members of the graduating class who pass the best examinations in agriculture. Income in 1892, . .	52 50
Mary Robinson fund, in hands of college treasurer, given without conditions. The income has been appropriated for scholarships to worthy and needy students. Income in 1892, ...	48 14
Whiting Street fund, of $1,000, a bequest without conditions. To this sum was added $260 by vote of the trustees in January, 1887, it being the interest accrued on the bequest. Amount of fund Dec. 31, 1892, $1,260. Income in 1892, ...	51 15
Library fund, for use of the library, $8,303.99. Deposited in Amherst Savings Bank.	
Gassett scholarship fund; the sum of $1,000 was given by the Hon. Henry Gassett as a scholarship fund. Income in 1892, ...	42 94
Total, ...	$32,099 46

To this sum must be added amount of tuition, room rent, receipts from sales of farm and botanic gardens; amount of same can be learned from statement of treasurer, tuition and room rent being included in term bill.

This is to certify that I have this day examined the accounts of George F. Mills, treasurer *pro tem.* of the Massachusetts Agricultural College, from Jan. 1, 1892, to Jan. 1, 1893, and find the same correct, properly kept and vouched for, the balance in treasury being five thousand and forty-two and $\frac{32}{100}$ dollars ($5,042.32), which sum is shown to be in the bank.

CHAS. A. GLEASON, *Auditor.*

FARM REPORT.

The past year has been one of unusual prosperity on the farm. The area under cultivation has been somewhat greater than last year, having been increased by the continued process of clearing of stumps and drainage wherever required.

The aggregate value of the crops of the farm for the past year, exclusive of those used for soiling, has amounted to $5,934. The various forage crops which furnished green fodder for our cows gave an aggregate yield of 242 tons, which must have been worth an average of $3 per ton; a total value, therefore, of $726, which raises the aggregate value of the crops produced to $6,660, — an increase over the crops of last year of about $550, and, as compared with the crops of 1890, of $1,750.

The receipts of the year for sales and work done by teams and men have amounted to $5,983.13; those of last year amounted to $5,030.09. The receipts of this year, then, exceed those of last year by rather over $950. We now have on hand for sale six hundred bushels of potatoes, at least sixty tons of hay and five hundred bushels of corn. We have, moreover, a liberal supply of forage, roots and silage for our large stock of cattle, and are monthly making not less than $260 worth of cream. The chief receipts for the past year were for the following items: —

Milk, cream and calves,	$2,697 34
Potatoes,	331 65
Sheep, lambs and wool,	556 20
Pigs and hogs,	252 12
Beef and dry cows,	143 51
Squashes,	166 00
Hay,	80 13
Labor of men and teams,	373 75
Percheron colt,	275 00
Total,	$4,875 70

The number of acres in the various crops of the farms was as follows: hay, 75; field corn, 17½; corn for fodder and for the

silo, 17; potatoes, 10; mangolds, 4; Swedes, ½; carrots, ½; soya beans, 2; squashes, 2; millet, 2; rye, 5; oats and vetches, 4; barley and pease, 5; oats, for hay, 3½, — a total of 148 acres, or, deducting land which produced two crops, 137 acres.

A large proportion of our old mowings are generally top-dressed with manure, and most of the balance with fertilizers. In providing for our other crops, our general plan has been to use both manure and fertilizer for each. The land is almost invariably ploughed in fall, and the manure is spread upon the surface during winter and spring about as soon as it is made. In the case of sod land the soil is prepared for seed in spring by the use of the wheel and acme harrows. Old land is reploughed lightly in spring. Fertilizers are for the most part spread broadcast just before planting, and harrowed in; for corn and potatoes a part is put in the drill at the time of planting. In the selection of fertilizers, our general plan has been to buy materials and make our own mixtures. The particular articles used may vary from year to year, according to the markets. Our aim is to buy needed plant food at lowest prices. A part of our nitrogen we generally look for in nitrate of soda, which acts more promptly than any other nitrogenous fertilizer. The balance we may get in dry ground fish, dried blood or bone meal. For our general crops, we take potash in the form of muriate, but for potatoes select the sulphate. Our phosphoric acid for immediate use we get in plain superphosphate; but to feed the crop later in the season and in subsequent years we may take bone meal, dry ground fish or tankage.

The crops of the year have been generally good, though neither hay nor potatoes gave a heavy yield. The fruit of the policy of carrying a larger stock of cattle for the consumption on the farm of the bulk of its products, which was inaugurated two years ago, has already become evident in increased productive capacity. This policy, combined with a system of progressive improvement chiefly by drainage of the parts of our farm still needing it, must, in a few years, still further largely increase the annual value of our products.

Hay. — About one-half of the seventy-five acres cut for hay lies about and in front of the college buildings, and has been in grass seven or eight years or more. The prevailing species is Kentucky blue-grass, which has gradually taken the place of timothy and red-top. The blue-grass is so badly injured by the attack of a maggot which works in the stem, and which we are unable to repel, that the yield of hay is never satisfactory here. This variety is a fine grass for pastures or lawns, but not for mowings. The large

proportion of mowing of this character accounts in a great measure for our comparatively light hay crop; but another cause for the seemingly low yield is found in the fact that some sixteen acres after being cut early were used for pasture the balance of the season. This portion is land which has already been ploughed or which will be ploughed next season after further pasturage. It would have yielded a considerable crop of rowen. Our yield of hay this year was: first crop, 120 tons; second crop, 40 tons, — a total of 160 tons, or a little more than two tons per acre.

As it is the policy to keep the land about and in front of the buildings permanently in grass, an effort will be made to increase its productiveness by occasionally ploughing and reseeding. Ten acres have been thus treated during the past season.

Corn. — Our corn was all grown in one field of thirty-four and one-half acres. The varieties were: Pride of the North, seventeen and one-half acres; Longfellow, fifteen acres; Leaming and Southern White, one acre each. The first was field-cured, as also were four acres of the Longfellow. The crop was fourteen hundred bushels of grain of splendid quality, an average of rather over sixty-five bushels of shelled corn to the acre. The yield was considerably reduced in some parts of the field by wire worms, which thinned the crop seriously. Where not so thinned, and especially on that part of the field thoroughly tile-drained, the yield was heavy.

A half-acre of each of the two varieties, Longfellow and Pride of the North, was harvested separately, for the purpose of comparing the two kinds. The Longfellow was husked earlier than the other, but the shrinkage in drying was carefully determined. One hundred and fifty pounds of corn in the ear of each variety was thoroughly air-dried and then shelled, and from the results thus obtained the yields of corn have been computed: —

Weights at Time of Husking.

Longfellow, . .	stover, 3,700 pounds;	corn in ear, 3,020 pounds.
Pride of the North, .	stover, 3,350 pounds;	corn in ear, 3,100 pounds.

Shrinkage in Drying and Shelling.

Pride of the North, ...	19 per cent.
Longfellow, ...	34 per cent.

Yields of Grain.

Longfellow, . .	1,993 pounds, or 35½ bushels, from one-half an acre.
Pride of the North, .	2,511 pounds, or 45 bushels, from one-half an acre.

Percentage of Cob.

Longfellow,	19 per cent.
Pride of the North,	16 per cent.

The superiority of the Pride of the North is well brought out by these figures, but they do not do it complete justice. The weight of stover, it will be seen, was greater for the Longfellow. It should be remembered that this was husked earlier; the stover was not as dry as was the other. I have no doubt the dry weight of stover was greater for the Pride of the North, but no moisture tests were made.

Of the balance of the field the crop on six acres was fed green. This was of the Longfellow variety. The crop from about seven acres, five of the Longfellow variety and one each of Leaming and Southern White, was put into the silos, giving a gross yield, as determined by measurement in the silos, of one hundred and fifty tons. The crop from one-half an acre of each was weighed as hauled with the following results: —

Southern White,	12 tons.
Leaming,	10½ tons.
Longfellow,	7 tons.

The crops were carefully sampled, and have been analyzed with the following results: —

	Southern White. (Per Cent.)	Leaming. (Per Cent.)	Longfellow. (Per Cent.)
Moisture,	85.18	76.22	72.19
Dry matter,	14.82	23.78	27.81
Analysis of Dry Matter.			
Crude ash,	5.90	6.78	7.19
Crude fat,	1.84	2.86	3.26
Crude protein,	9.22	11 24	9 79
Crude cellulose,	23.26	21.87	18.27
Nitrogen-free extract,	59.78	57.25	63.11

Upon these analyses as a basis we find by calculation that the Southern White gave a yield which contained 3,552 pounds of dry matter to the half-acre; the Longfellow, 3,892 pounds; and the

Leaming, 4,998 pounds. The last-named variety, then, gave a product considerably more valuable than either of the others, provided its dry matter is equal in composition to the others. Examination shows it to be perhaps the most valuable, as it contains the highest percentage of protein and a large percentage of fat. The Longfellow is superior in composition to the Southern White, and, as it excels that variety in yield of dry matter also, there can be no doubt that it is preferable.

When sampled, the Longfellow corn was well glazed and beginning to dry; the Leaming was quite generally in the dough; while most of the ears on the Southern White were yet not fully grown.

In some parts of our field the yield of the Longfellow variety was much heavier than upon the half-acre weighed. The rapidity with which our silo filled is the evidence of this; and calculation, based upon the amount of fodder in our silos (allowing it to weigh about 45 pounds per cubic foot) and the known acreage, show that the average yield of the Longfellow variety put into the silo must have been about 20 tons per acre, which would equal a yield of 5,560 pounds of dry matter per half-acre. This places the Longfellow undoubtedly ahead of the Leaming as a crop for the silo.

The silage made from the different varieties will be subjected to analysis and will be used in feeding experiments, that still further light may be thrown upon the question as to the varieties best for the silo.

The account with our field of corn is as follows: —

	Dr.
To ploughing, applying fertilizers and harrowing,	$154 00
planting,	23 80
three-fourths cost of fertilizers,	185 00
one-half cost 140 cords of manure, at $4,	280 00
cultivation and hoeing,	126 50
ensiling, 7 acres,	90 00
cutting and stooking, 21½ acres,	50 00
husking 2,800 baskets, at 5 cents,	140 00
	$1,049 30
	Cr.
By 85 tons green fodder, at $3,	$255 00
150 tons silage, at $4,	600 00
70 tons stover, at $8,	560 00
1,400 bushels shelled corn, at 50 cents,	700 00
	$2,115 00
Balance in favor of crop,	$1,065 70

Twenty acres of our corn land was in grass last year, six acres pastured throughout the season with sheep, the balance once mown and then pastured the remainder of the season. The remainder of the field was in corn last year, and this part was seeded to grass in the standing corn in August It was upon this part of the field that the crop for green fodder and for the silo was grown.

All parts of this field were ploughed in the fall of 1891 and manured at the rate of four cords per acre. The part in field corn received in addition muriate of potash, 150 pounds; fish guano, 200 pounds; plain superphosphate, 150 pounds; and nitrate of soda, 100 pounds per acre.

The fodder and silage corn received per acre fertilizer as follows: muriate of potash, 125 pounds; fish guano, 100 pounds; plain superphosphate, 100 pounds; and nitrate of soda, 100 pounds.

Potatoes. — This crop occupied a field of ten acres, one acre being land newly cleared of stumps; the balance, last year in fodder crops, first rye, later barley and pease, and oats and pease, the crops following the rye manured, the rye receiving only a light spring dressing of nitrate of soda, fish guano and muriate of potash. The crop this year received fertilizer at the following rates per acre: sulphate of potash, 200 pounds; superphosphate, 200 pounds; bone meal, 200 pounds; fish guano, 200 pounds; and nitrate of soda, 150 pounds. These were mixed and two-thirds applied broadcast, the balance in the drill. The Aspinwall planter was used, and put in both seed and fertilizer satisfactorily, though some difficulty was experienced in regulating the fertilizer attachment so as to distribute just the desired amount. Frequent rains made it difficult to destroy the bugs, and some damage was done. There was no rot, and, considering the generally poor crops this year, ours was fairly satisfactory. The hot, dry weather in July no doubt seriously lessened the yield. In digging the crop we used the Hallock potato digger. It did not by any means bring all the tubers to the surface, but it much lessened the labor of digging, and I think, in the ten acres, paid for itself. The standing of this crop is shown in the following table: —

430 bushels, at 80 cents, sold, . . .	$344 00	
600 bushels, in cellar, at 85 cents, . .	510 00	
		$854 00
Three-fourths the fertilizer used, . .	$93 45	
90 bushels seed, at 40 cents, . . .	36 00	
Labor, raising and harvesting, . . .	160 25	
		289 70
Balance in favor of crop, ...		$564 30

Beets. — Four acres of warm alluvial loam, last year in squashes and potatoes, raised on fertilizers, were devoted to fodder beets. The land was prepared in accordance with our usual practice, manure at the rate of 5 cords, and 100 pounds fish guano, 150 pounds muriate of potash, 150 pounds nitrate of soda and 200 pounds common salt per acre being applied. The varieties were Carter's Orange Globe three acres, and Lane's American Sugar one acre. The seed was sown April 24. Some transplanting was required, but in the end there were few blank spaces. The field proved weedy, and the labor cost was high. The crop amounted to nearly thirty tons per acre. The financial outcome is shown below: —

112 tons beets, at $3, ...		$336 00
One-half cost manure, 20 cords, at $4, .	$40 00	
Three-fourths cost of fertilizers, . .	30 00	
Labor, ...	152 00	
		222 00
Balance in favor of crop, ...		$114 00

Squashes. — Two acres of land, from which a crop of rye cut for green feed had been taken, were devoted to this crop. The soil is a warm alluvial loam, and had been used for potatoes grown on fertilizer in 1891. The crop was manured in the hill, and the soil received a broadcast application of 200 pounds bone meal, 125 pounds muriate of potash and 200 pounds superphosphate per acre. The season of planting, a little later than usual, was hot and dry, and the seed was slow in germinating. The crop was rather small. The financial standing follows: —

8¾ tons squashes sold for, ...	$166 00	
2 tons soft squashes fed to cattle, at $4, .	8 00	
		$174 00
Labor, raising, harvesting and marketing, .	$47 50	
Two cords manure, ...	8 00	
Three-fourths fertilizer used, . . .	12 75	
		68 25
Balance in favor of crop, ...		$105 75

Swedes. — One-half acre in this crop was sown June 25, on land similar to that on which the beets were grown. It was manured like the beets, and received also muriate of potash 75 and superphosphate 150 pounds. The crop was a fine one. We figure the entire expense of growing the crop — labor, manure and fertilizer included — at $17.50. The yield was eight tons, worth $32, leaving a balance in favor of crop of $14.50.

Soya Beans. — Two acres of the warm alluvial loam on which potatoes were grown last year were devoted to this crop. The seed was sown May 25, in rows two and one-half feet apart. The land received manure at the rate of six cords, and 200 pounds muriate of potash, 200 pounds superphosphate, 100 pounds nitrate of soda and 100 pounds of fish guano per acre, applied in our customary manner. The growth was unusually fine, but the vines rusted somewhat, which reduced the yield. The cost of production and harvesting, manures and fertilizers, being charged in the usual manner, was $97. The yield was thirty-six bushels of beans and three tons of straw.

Millets. — One acre of land, similar to that used for beans, was devoted to each of two kinds of millets, viz., *Panicum miliaceum* or "panicle" millet, and *Panicum crus galli* or "crow-foot" millet. These crops are alluded to in the report of the agricultural department of the Hatch Experiment Station, to which the reader is referred for detailed statements of yields. The land was prepared as for beans, receiving per acre six cords of manure, 150 pounds muriate of potash, 200 pounds fish guano and 200 pounds superphosphate. The seed was sown at the rate of eight quarts per acre for the first and six quarts for the second. The yields were almost identical for both varieties, — about twelve tons per acre.

Rye. — Five acres of the land used last year for potatoes were given up to this crop. No fertilizer was put on when the seed was sown, but in early spring we applied, per acre, 125 pounds muriate of potash, 100 pounds fish guano and 150 pounds nitrate of soda. The growth was remarkably luxuriant. We commenced to cut for green feed May 12, and used all that forty cows would eat, up to the time when the crop was fully headed out, — May 30, — clearing only two and one-half acres. The balance was allowed to ripen, and when fully grown averaged over six feet in height, some of it reaching fully seven feet. The yield of grain was comparatively light, amounting, it is estimated from what has been threshed, to about forty-five bushels. The straw weighed about eight and one-half tons. This crop, at $12 per ton for the straw and 70 cents per bushel for the grain, is worth $133.50. The labor cost (threshing not included) plus three-fourths the value of fertilizer applied amounts to $35.40, leaving an apparent balance of $98.10 in favor of the crop; but from this sum must be deducted the cost of threshing, which is not yet finished.

English Turnips. — Four acres which had produced a crop of oats and vetches for green fodder were ploughed and manured about

August 1, and sown with clover and English turnips. From this field we harvested twenty-two tons of fine roots, and the clover looks well. The cost of the turnips was very small, the labor required being only the work of harvesting, while the crop must be worth $66 for feeding sheep and cattle.

Soiling Crops. — Our large stock of milch cows — forty being about the average number — are fed almost exclusively in the barn, summer as well as winter. They are allowed a few hours' run daily upon grass lands which are soon to be ploughed, more, however, for exercise than for feed. They are confined by means of movable fences in small enclosures, about a dozen cows in each, and are from time to time shifted to fresh enclosures. In this way previous to August 1 we twice fed over six acres of land, at the same time manuring it evenly and liberally. This land was then ploughed, and with a small application of fertilizer produced a heavy crop of barley and pease, which furnished abundance of green feed from October 9 to November 12, not being at all injured by frost at the latter date.

By our system of soiling the productive capacity of our farm is being steadily increased, and I feel well satisfied with the results in every respect. So many are unfamiliar with the system, and so frequently do we see inquiries as to what to sow, that I append the following table, which may serve for a guide. The average number of cows fed in the barn has been almost exactly thirty-seven, and they received little dry feed during the summer, but summer as well as winter they receive a moderate allowance of grain, amounting generally to about six to eight pounds daily of mixed bran, cotton seed, linseed or corn meal.

Green Feed for Thirty-seven Cows.

CROP.	Date of Planting.	Date of Feeding.	Acreage.	Yield in Tons.
Rye, ...	Sept. 25, 1891.	May 12–30.	2½	22
Grass and clover, . .	August, 1891.	May 30–July 4.	8	50
Oats and vetch, . .	April 16.	July 5–23.	3	30
Corn, ...	May 10.	July 24–29.	½	7
Millets, Japanese, .	May 28.	July 30–Aug. 7.	½	8
Corn, ...	May 15–25.	Aug. 8–Oct. 8.	5½	80
Barley and pease, . .	Aug. 7.	Oct. 9–Nov. 12.	5	45

Most of these crops have been mentioned in previous reports, and detailed notice is not necessary at this time. The millets have been favorably alluded to elsewhere. They come into condition to feed a little earlier than corn reaches its full development, and seem desirable additions for this place.

Later than November 12 our sheep and young stock are given a run in our corn fields, in which white mustard is sown after the last hoeing. This produces a considerable growth of feed which is much relished by all classes of stock, and remains green usually well into the month of December. The mustard takes up the soluble nitrates of the soil and holds them for the succeeding crop. It also tends to keep down the growth of undesirable weeds, and does not itself become a weed.

Farm Live Stock. — Our stock has generally maintained a good average of health throughout the year. We have met with a few losses among our cattle, from causes which we are unable completely to control, though the policy of promptly weeding out inferior animals, followed for the past few years, has reduced our losses from such causes. We are unable entirely to prevent abortion among our cows. We have a considerable number of cases every year.

The injury to our flock of Southdowns by dogs, which occurred in September, was of a serious nature. Twelve animals were either killed or so badly injured as to necessitate immediate slaughter, and several others were injured more or less severely.

Returns from the Dairy. — The average number of cows in milk during the past year has been thirty-three, *exclusive of those which have been in process of drying off.* The gross returns from these cows have amounted to $2,697.34 for new milk, cream and calves. Besides this, we have had 29,736 gallons of skim-milk, which at two cents per gallon adds $594.72 to the above figure, making the total gross returns from our cows $3,292.06. On the basis of thirty-seven cows as the average number milked, the gross return per cow is $88.98; or, on the basis of the total average number of cows, including animals dry, viz., forty, the gross return per cow amounts to $82.30. In view of the fact that our herd contains cows of all ages, heifers as well as mature animals, and others beyond their prime, this return is considered creditable. The average gross cost of feed amounts to from $70 to $75 per animal; the average net cost (four-fifths manurial value deducted) to from $38 to $42. We have, then, from $40 to $44 to pay for interest

on investment, depreciation in value of stock and care of animals, — a sum considerably greater than is sufficient to cover these items.

Milk Record. — I include here a few milk records, either entirely made or finished during the past year: —

Holstein-Friesian.

Beth Hoorn, age eight years: —
Best single day, 82 pounds six ounces.
Best seven days (ending March 19), 524 pounds 14 ounces.
Best thirty days (ending March 5), 2,007 pounds 7 ounces.
Milking period (ten months), 12,800 pounds.

Emelia Pledge, with first calf dropped at age of three years five months: —
Best single day, 61 pounds 4 ounces.
Best month, 1,346 pounds 14 ounces.
One year, 12,330 pounds 5 ounces.

Cornelia Artis, age eight years: —
Best year, 12,343 pounds 11 ounces.

Cornelia Pledge, with second calf, age three years six months: —
Best year, 10,585 pounds eight ounces.

Maribel Artis, two years old June, 1892, calved Feb. 8, 1892: —
Yield to date, 7,153 pounds 5 ounces.

Twilight Artis, calved when one year ten months old: —
Yield to date (eleven months), 8,772 pounds 7 ounces.

Grade Cows, Jersey and Shorthorn Blood predominating.

All calved late in 1891.	Yield for 1892: —
Dinah,	7,606 pounds 10 ounces.
Phœbe,	8,002 pounds.
Meg,	7,120 pounds.
Viola (nearly pure Jersey),	5,120 pounds 13 ounces.
Topsy,	8,339 pounds 15 ounces.
Brindle,	8,040 pounds 7 ounces.
Nancy,	7,898 pounds 15 ounces.

The average annual yield of our entire herd (obtained by dividing the total number of pounds of milk produced in the year by the average number of cows kept, whether dry or in milk, viz., forty) is 6,465 pounds.

The total number of spaces (Cooley creamer) of cream produced during the year was 68,159, equivalent, at 6.25 spaces to one pound of butter, to 10,909.4 pounds of butter, an average of 272.7 pounds of butter per cow. In addition to this we have fattened calves and sold new milk to the amount of $82.49, equivalent to 330 pounds of butter at twenty-five cents per pound, which would

increase the average yield per cow by 8¼ pounds, making the total for each of the forty cows kept about 281 pounds. It should be remembered that our herd includes a number of heifers and cows beyond their prime.

Our stock at present consists of the following animals: —

Horses. — Percherons: one stallion, one mare, one stallion colt and one mare colt; one three-fourths Percheron mare; one pair half-blood Percheron mares and three geldings. Total, ten.

Cattle. — Ayrshires: one male, eight females; Guernsey: one bull; Holstein-Friesian: two males, eleven females; Jersey: one male, two females; Shorthorn: one female; grades: forty cows and heifers. Total, five bulls, sixty-three cows and heifers.

Sheep. — Southdowns: one ram, twenty-one breeding ewes, six ram lambs and six ewe lambs. Total, thirty-four.

Swine. — Small Yorkshires: two boars, four breeding sows, thirty-three pigs and fat hogs; Tamworth: one boar and one sow. Total, forty-one.

Equipment. — We have made few additions to our equipment during the year, and those have been acquired by purchase. The more important articles are the Walter A. Wood tubular steel mower, Ross ensilage cutter, Hallock potato digger, and the Hauck and Comstock lion fodder cutter and crusher. All these machines do their work in a fairly satisfactory manner, but especially would I commend the mower and the Ross cutter. The lion cutter and crusher does good work, but is not made in sizes large enough for a heavy power, and therefore has not the capacity needed where so much material is to be handled as here.

Permanent Improvement. — The increased acreage under cultivation, and the fact that we have employed less help than usual, explain the comparatively small amount of work in the line of permanent improvement that we have been able to accomplish. The inconvenient location of our barn — in one corner of the area tributary to it — greatly increases the cost of work, and our teams have been pushed even harder than is consistent with first-class condition in keeping up with the routine work of the farm. We have, however, cleared about three-fourths of an acre of stumps which were very thick therein, and put in a few more tiles. We have also built a permanent roadway and substantial bridge across the west end of the ravine and its brook; we have reploughed and

reseeded ten acres of our permanent mowing. It is believed also that we have effected a large share of improvement in the cleanness and general condition of all our fields, as well as in their fertility, which will show in largely increased crops in the near future.

In conclusion, I desire to express my thanks to all, both among superiors and subordinates, for the hearty co-operation in the efforts which have been put forth to bring the farm into such condition that it shall the better fulfil the important objects in view in its management, — to make it a model for the farmers of the State and an efficient means of illustration and instruction, both for students and the many who yearly visit us.

WM. P. BROOKS,
Professor of Agriculture.

MILITARY DEPARTMENT.

AMHERST, MASS., Dec. 21, 1892.

To President H. H. GOODELL.

SIR: — I have the honor to submit the following report, pertaining to the military department of the college, for the year ending December 31, 1892.

In compliance with Special Orders, No. 105, dated headquarters of the army, Adjutant-General's Office, Washington, May 4, 1892, I reported for duty to the president of the college on August 16, 1892, as professor of military science and tactics.

The college opened on September 7 for the fall term, and I then took command of the battalion of cadets. There have been three drills each week during the term, each drill being for one hour; all students are required to attend these drills, except those excused by the surgeon on account of physical disability. The entire battalion has been instructed, as thoroughly as the limited time would permit, in the new "infantry drill regulations," including "school of the soldier," "school of the company" and "extended order." The sophomore class has received special instruction in "bayonet exercise" and artillery drill. The entire battalion has also had frequent instruction in "target practice." Theoretical instruction has been given the three upper classes, for one hour each week, in the recitation room, in the new "infantry drill regulations;" in addition, the senior class has received instruction by lectures on military law, and the sophomore class in artillery. The interest taken by the students in their military duty, and the discipline of the corps, appear to be excellent.

BATTALION ORGANIZATION.

Commandant of Cadets: — First Lieut. W. M. DICKINSON, Seventeenth United States Infantry.

Field and Staff: — Cadet Major, F. H. HENDERSON; Cadet First Lieut. and Adjutant, J. R. PERRY; Cadet First Lieut. and Quartermaster, H. J. HARLOW; Cadet First Lieut. and Fire Marshal, F. S. HOYT; Cadet Sergeant Major, H. P. SMEAD; Cadet Quartermaster Sergeant, G. H. MERWIN.

Color Guard: — Cadet Color Sergeant, L. H. Bacon; Cadet Color Corporal, F. L. Greene; Cadet Color Corporal, A. J. Morse.

Band: — Cadet First Lieut. and Band Leader, E. H. Lehnert; Cadet First Sergeant and Drum Major, P. E. Davis; Cadet Sergeant, J. H. Putnam.

Company A.

Cadet Capt. A. E. Melendy.
Cadet First Lieut. F. A. Smith.
Cadet Second Lieut. E. J. Walker.
Cadet First Sergeant T. S. Bacon.
Cadet Sergeant L. Manley.
Cadet Sergeant W. E. Sanderson.
Cadet Corporal H. M. Fowler.
Cadet Corporal E. T. Dickinson.
Cadet Corporal H. J. Fowler.
Cadet Corporal F. G. Averell.

Company B.

Cadet Capt. G. F. Curley.
Cadet First Lieut. L. W. Smith.
Cadet Second Lieut. J. Baker.
Cadet First Sergeant A. C. Curtis.
Cadet Sergeant R. E. Smith.
Cadet Sergeant C. L. Brown.
Cadet Corporal L. M. Barker.
Cadet Corporal C. H. Higgins.
Cadet Corporal C. H. Spaulding.
Cadet Corporal T. F. Keith.

Company C.

Cadet Capt. H. D. Clark.
Cadet First Lieut. F. G. Bartlett.
Cadet Second Lieut. F. T. Harlow.
Cadet First Sergeant J. E. Gifford.
Cadet Sergeant A. H. Kirkland.
Cadet Sergeant A. H. Cutter.
Cadet Corporal G. E. Smith.
Cadet Corporal E. H. Alderman.
Cadet Corporal E. L. Boardman.
Cadet Corporal R. F. Pomeroy.

Company D.

Cadet Capt. C. A. Goodrich.
Cadet First Lieut. E. A. Hawks.
Cadet Second Lieut. H. F. Staples.
Cadet First Sergeant S. F. Howard.
Cadet Sergeant H. G. Stockwell.
Cadet Sergeant E. D. White.
Cadet Corporal C. F. Walker.
Cadet Corporal L. J. Shepard.
Cadet Corporal H. W. Lewis.
Cadet Corporal I. C. Greene.

The number of cadets in the battalion is 136.

Drill Hall.

The drill hall has been furnished with electric lights during the past year. I would most earnestly call your attention to the need of a new floor in the hall itself; concrete, of which the present floor is made, is about the worst possible substance that could have been selected; it is cold, dusty when marching, and the stocks of several of the guns have been broken I believe solely on account of the nature of the floor. A suitable floor of hard pine can be put in the hall for a cost, I understand, of five hundred dollars. A gallery, the cost of which would be about one hundred dollars, should also be placed in the hall, as now there is no place for visitors except on the floor of the hall, where they are able to see but little, and are also in the way during drill. I believe that both these improvements should be made, as the hall would then be much more suitable for military purposes, and also for any

exercises for which it might be required. At the present time the drill hall is also used for a gymnasium, and the apparatus for that purpose not only takes up room, but interferes in other ways with the military exercises. The hall being no larger than is absolutely required for military purposes, I would recommend that a suitable building be provided for use as a gymnasium, including also a bowling alley.

Dormitories.

The rooms in North College are in very good repair, a considerable amount of work having been done on them during the past summer; still, the ceilings of several should be calcimined or papered as soon as convenient. Ventilation is much needed in both the east and west hallways of this building, there now being no way in which this can be properly done. For that purpose I would recommend that ventilators be placed in the roof over each of these hallways. I would also recommend that either the roof of the porch or the entire porch at the east end of this building be removed, as the rooms enclosed by it are so dark and cold that none of the students desire to occupy them. In South College most of the rooms are in good condition, although the walls of four or five should be either papered or calcimined. I would also recommend that the openings in front of the basement windows on the east side of this building be covered, as in their present shape I consider them extremely dangerous.

Respectfully submitted,

W. M. DICKINSON,

First Lieutenant Seventeenth United States Infantry.

CALENDAR FOR 1893–94.

1893.

January 3, winter term begins, at 8.15 A.M.

March 23, Thursday, winter term closes, at 10.30 A.M.

April 4, Tuesday, spring term begins, at 8.15 A.M.

June 18, Sunday,
- Baccalaureate sermon.
- Address before the College Young Men's Christian Association, by A. E. Dunning, D.D., editor of "The Congregationalist."

June 19, Monday,
- Prize speaking.
- Grinnell prize examination of the senior class in agriculture.

June 20, Tuesday,
- Meeting of the alumni.
- Military exercises.
- President's reception.

June 21, Wednesday, Commencement exercises.

June 22, Thursday, examinations for admission, at 9 A.M., Botanic Museum, Amherst; at Jacob Sleeper Hall, Boston University, 8 Somerset Street, Boston; and at the Sedgwick Institute, Great Barrington.

September 5, Tuesday, examinations for admission, at 9 A.M., Botanic Museum.

September 6, Wednesday, fall term begins, at 8.15 A.M.

December 20, Wednesday, fall term closes, at 10.30 A.M.

1894.

January 3, Wednesday, winter term begins, at 8.15 A.M.

March 22, Thursday, winter term closes, at 10.30 A.M.

THE CORPORATION.

	Term expires
FRANCIS H. APPLETON of Lynnfield,	1894
WILLIAM WHEELER of Concord,	1894
ELIJAH W. WOOD of West Newton,	1895
CHARLES A. GLEASON of New Braintree,	1895
DANIEL NEEDHAM of Groton,	1896
JAMES DRAPER of Worcester,	1896
HENRY S. HYDE of Springfield,	1897
MERRITT I. WHEELER of Great Barrington,	1897
JAMES S. GRINNELL of Greenfield,	1898
JOSEPH A. HARWOOD of Littleton,	1898
WILLIAM H. BOWKER of Boston,	1899
J. D. W. FRENCH of Boston,	1899
J. HOWE DEMOND of Northampton,	1900
ELMER D. HOWE of Marlborough,	1900

Members Ex-Officio.

His Excellency Governor WILLIAM E. RUSSELL, *President of the Corporation.*

HENRY H. GOODELL, *President of the College.*

JOHN W. DICKINSON, *Secretary of the Board of Education.*

WILLIAM R. SESSIONS, *Secretary of the Board of Agriculture.*

JAMES S. GRINNELL of Greenfield,
Vice-President of the Corporation.

WILLIAM R. SESSIONS of Hampden, *Secretary.*

GEORGE F. MILLS of Amherst, *Treasurer, pro tem.*

CHARLES A. GLEASON of New Braintree, *Auditor.*

Committee on Finance and Buildings. *

JAMES S. GRINNELL. HENRY S. HYDE.
J. HOWE DEMOND. CHARLES A. GLEASON.
DANIEL NEEDHAM, *Chairman.*

Committee on Course of Study and Faculty. *

WILLIAM H. BOWKER. JOSEPH A. HARWOOD.
ELMER D. HOWE. J. D. W. FRENCH.
WILLIAM WHEELER, *Chairman.*

Committee on Farm and Horticultural Departments. *

ELIJAH W. WOOD. JAMES DRAPER.
FRANCIS H. APPLETON. MERRITT I. WHEELER.
WILLIAM R. SESSIONS, *Chairman.*

Committee on Experiment Department.*

DANIEL NEEDHAM. ELIJAH W. WOOD.
WILLIAM WHEELER. JAMES DRAPER.
WILLIAM R. SESSIONS, *Chairman.*

Board of Overseers.

THE STATE BOARD OF AGRICULTURE.

Examining Committee of Overseers.

E. A. HARWOOD, ... of North Brookfield.
A. C. VARNUM, ... of Lowell.
GEORGE CRUICKSHANKS, . . of Fitchburg.
GEORGE L. CLEMENCE, . . of Southbridge.
DR. WILLIAM HOLBROOK, . . of Palmer.
CHAS. A. MILLS, ... of Southborough.

The Faculty.

HENRY H. GOODELL, LL.D., *President.*
Professor of Modern Languages and English Literature.

* The president of the college is ex-officio a member of each of the above committees.

LEVI STOCKBRIDGE,
Professor of Agriculture, Honorary.

CHARLES A. GOESSMANN, Ph.D., LL.D.,
Professor of Chemistry.

SAMUEL T. MAYNARD, B.Sc.,
Professor of Botany and Horticulture.

CLARENCE D. WARNER, B.Sc.,
Professor of Mathematics and Physics.

CHARLES WELLINGTON, Ph.D.,
Associate Professor of Chemistry.

CHARLES H. FERNALD, Ph.D.,
Professor of Zoölogy.

Rev. CHARLES S. WALKER, Ph.D.,
Professor of Mental and Political Science.

WILLIAM P. BROOKS, B.Sc.,
Professor of Agriculture.

GEORGE F. MILLS, M.A.,
Professor of English.

JAMES B. PAIGE, V.S.,
Professor of Veterinary Science.

WALTER M. DICKINSON, 1st Lieut. 17th Infantry, U. S. A.,
Professor of Military Science and Tactics.

ROBERT W. LYMAN,
Lecturer on Farm Law.

HENRY H. GOODELL, LL.D.,
Librarian.

FRED S. COOLEY, B.Sc.,
Farm Superintendent.

Graduates of 1892. *

Beals, Alfred Tennyson,	Greenfield.
Boynton, Walter Ira (Boston Univ.),	North Amherst.
Clark, Edward Thornton (Boston Univ.),	Granby.
Crane, Henry Everett (Boston Univ.),	Weymouth.
Deuel, James Edward (Boston Univ.),	Amherst.
Emerson, Henry Bennett,	Gloucester.
Field, Judson Leon (Boston Univ.),	Leverett.
Fletcher, William (Boston Univ.),	Chelmsford.
Graham, Charles Sumner (Boston Univ.),	Holden.
Holland, Edward Bertram (Boston Univ.),	Amherst.
Hubbard, Cyrus Moses (Boston Univ.),	Sunderland.
Knight, Jewell Bennett (Boston Univ.),	Belchertown.
Lyman, Richard Pope,	Boston.
Plumb, Frank Herbert (Boston Univ.),	Westfield.
Rogers, Elliot (Boston Univ.),	Allston.
Smith, Robert Hyde (Boston Univ.),	Amherst.
Stockbridge, Francis Granger (Boston Univ.),	Northfield.
Taylor, George Everett (Boston Univ.),	Shelburne.
Thomson, Henry Martin (Boston Univ.),	Monterey.
West, Homer Cady (Boston Univ.),	Belchertown.
Willard, George Bartlett (Boston Univ.),	Waltham.
Williams, Milton Hubbard (Boston Univ.),	Sunderland.
Total,	22

Senior Class.

Baker, Joseph,	Dudley.
Bardin, James Edgar,	Dalton.
Bartlett, Fred Goff,	Hadley.
Clark, Henry Disbrow,	Plainfield.
Curley, George Frederick,	Upton.
Davis, Herbert Chester,	Amherst.
Goodrich, Charles Augustus,	Hartford, Conn.
Harlow, Francis Turner,	Marshfield.
Harlow, Harry James,	West Boylston.
Hawks, Ernest Alfred,	Williamsburg.
Henderson, Francis Howard,	Malden.
Howard, Edwin Carleton,	Wilbraham.
Hoyt, Franklin Sherman,	Cheshire, Conn.
Lehnert, Eugene Hugo,	Clinton.
Melendy, Alphonso Edward,	Sterling.

* The annual report, being made in January, necessarily includes parts of two academic years, and the catalogue bears the names of such students as have been connected with the college during any portion of the year 1892.

Perry, John Richards,	Boston.
Smith, Cotton Atwood,	North Hadley.
Smith, Fred Andrew,	Lynn.
Smith, Luther Williams,	Ashfield.
Staples, Henry Franklin,	Leominster.
Tinoco, Luiz Antonio Ferreira,	Campos, Rio Janeiro, Brazil.
Walker, Edward Joseph,	Clinton.
Total,	22

Junior Class.

Alderman, Edwin Hammond,	Middlefield.
Averell, Fred Gilbert,	Amherst.
Bacon, Linus Hersey,	Spencer.
Bacon, Theodore Spalding,	Natick.
Barker, Louis Morton,	Hanson.
Barton, Charles Henry,	Dalton.
Boardman, Edwin Loring,	Sheffield.
Brown, Charles Leverett,	Feeding Hills.
Curtis, Arthur Clement,	Brooklyn, N. Y.
Cutter, Arthur Hardy,	Pelham, N. H.
Davis, Perley Elijah,	Worcester.
Dickinson, Eliot Taylor,	Amherst.
Fowler, Halley Melville,	South Gardner.
Fowler, Henry Justin,	North Hadley.
Gifford, John Edwin,	Brockton.
Greene, Frederic Lowell,	Shrewsbury.
Greene, Ira Charles,	Fitchburg.
Higgins, Charles Herbert,	Dover.
Howard, Samuel Francis,	Wilbraham.
Johnson, Charles Frederic,	Littleton.
Keith, Thaddeus Fayette,	Fitchburg.
Kirkland, Archie Howard,	Norwich.
Lewis, Henry Waldo,	Rockland.
Lounsbury, Charles Pugsley,	Allston.
Manley, Lowell,	Brockton.
Mann, Henry Judson,	Maplewood.
Marvin, Samuel Barnard,	Richford, Vt.
Merwin, George Henry,	Westport, Conn.
Morse, Alvertus Jason,	Belchertown.
Morse, Elisha Wilson,	Brockton.
Park, Fred Ware,	South Chelmsford.
Parker, Frank Ingram,	Pittsfield.
Pomeroy, Robert Ferdinand,	South Worthington.
Putnam, Joseph Harry,	West Sutton.
Robbins, Dana Watkins,	Walpole.
Sanderson, William Edwin,	Hingham.
Sanford, George Otis,	Winchendon.
Shepard, Lucius Jerry,	Oakdale.
Smead, Horace Preston,	Greenfield.

Smith, George Eli,	Sheffield.
Smith, Ralph Eliot,	Newton Centre.
Spaulding, Charles Harrington,	East Lexington.
Stockwell, Harry Griggs,	Sutton.
Walker, Claude Frederic,	Amherst.
White, Elias Dewey,	South Sherborn.
Total,	45

Sophomore Class.

Bagg, Edward Oren,	West Springfield.
Ballou, Henry Arthur,	West Fitchburg.
Bemis, Waldo Louis,	Spencer.
Billings, George Austin,	South Deerfield.
Brown, William Clay,	Peabody.
Burgess, Albert Franklin,	Rockland.
Clark, Edile Hale,	Spencer.
Cook, Jay Erastus,	Hadley.
Cooley, Robert Allen,	South Deerfield.
Crehore, Charles Winfred,	Chicopee.
Davis, Alfred,	West Roxbury.
Dickinson, Charles Morrison,	Park Ridge, Ill.
Drury, Ralph Willard,	Athol Centre.
Duffield, William Charles,	Quincy Point.
Fairbanks, Herbert Stockwell,	Amherst.
Foley, Thomas Patrick,	Natick.
Frost, Harold Locke,	Arlington.
Goodell, John Stanton,	Amherst.
Hemenway, Herbert Daniel,	Williamsville.
Henderson, Edward Harris,	Malden.
Jones, John Horace,	Pelham.
Jones, Robert Sharp,	Dover.
Kuroda, Shiro,	Yamanouchi, Kitamura, Japan.
Lane, Clarence Bronson,	Killingworth, Conn.
Marsh, Jasper,	Danvers Centre.
Mason, Amos Hall,	Medfield.
Morse, Walter Levi,	Middleborough.
Potter, Daniel Charles,	Fairhaven.
Read, Henry Blood,	Westford.
Root, Wright Asahel,	Deerfield.
Smith, Arthur Bell,	North Hadley.
Stevens, Clarence Lindon,	Sheffield.
Sullivan, Maurice John,	Amherst.
Tobey, Frederick Clinton,	West Stockbridge.
Toole, Stephen Peter,	Amherst.
Warren, Frank Lafayette,	Shirley.
Weed, Percy Loring,	Boston.
White, Edward Albert,	Ashby.
Williams, John Sherman,	Middleborough.
Total,	39

Freshman Class.

Burrington, Horace Clifton,	Charlemont.
Clapp, Frank Lemuel,	Dorchester.
Clark, Harry Edward,	Wilbraham.
Cook, Allen Bradford,	Petersham.
Curley, Walter James,	Upton.
DeLuce, Frank Edmund,	Warren.
Dodge, William Bradford,	Jamaica Plain.
Edwards, Harry Taylor,	Chesterfield.
Fletcher, Stephen Whitcomb,	Rock.
Geary, Hiram Gilbert,	Pelham.
Green, Josiah Elton,	Spencer.
Hammar, James Fabens,	Swampscott.
Harper, Walter Benjamin,	Wakefield.
Hayward, Ralph Lyon,	Uxbridge.
Hubbard, Guy Augustus,	Ashby.
Jones, Benjamin Kent,	Middlefield.
Kinney, Asa Stephen,	Worcester.
Kinsman, Ernest Eugene,	Heath.
Kramer, Albin Maximilian,	Clinton.
Leamy, Patrick Arthur,	Petersham.
Marshall, James Laird,	South Lancaster.
Moore, Henry Ward,	Worcester.
Morse, Sydney Levi,	Foxborough.
Nichols, Robert Parker,	West Norwell.
Nutting, Charles Allen,	North Leominster.
Pentecost, William Lewis,	Worcester.
Poole, Erford Wilson,	North Dartmouth.
Poole, Isaac Chester,	North Dartmouth.
Rawson, Herbert Warren,	Arlington.
Read, Frederick Henry,	Wilbraham.
Robinson, Frank Dean,	Petersham.
Roper, Harry Howard,	East Hubbardston.
Saito, Seijiro,	Nemuro, Japan.
Sastré de Verand, Salome,	Tabasco, Mexico.
Scannell, Michael Edward,	Amherst.
Sellew, Merle Edgar,	East Longmeadow.
Shaw, Frederic Bridgman,	South Amherst.
Shultis, Newton,	Medford.
Shurtleff, Walter Davis,	Carver.
Stoddard, Samuel Harwood,	Rockland.
Tsuda, George,	Tokyo, Japan.
Vallentine, Florence May,	Florence.
Vaughan, Robert Henry,	Worcester.
Walsh, Tom Francis,	North Amherst.
Washburn, Frank Porter,	North Perry, Me.
Wentzell, William Benjamin,	Amherst.
Total,	46

Resident Graduates at the College and Experiment Stations.

Arnold, B.Sc., Frank Luman (Boston Univ.),	Belchertown.
Carpenter, B.Sc., Malcolm Austin (Boston Univ.),	Leyden.
Cooley, B.Sc., Fred Smith,	Sunderland.
Court, William Boyce (Magill Univ.),	Montreal, Canada.
Crocker, B.Sc., Charles Stoughton (Boston Univ.),	Sunderland.
Field, B.Sc., Henry John (Boston Univ.),	Leverett.
Haskins, B.Sc., Henry Darwin (Boston Univ.),	North Amherst.
Hitchcock, George Preston (Amherst Coll.),	Fitchburg.
Holland, B.Sc., Edward Bertram (Boston Univ.),	Amherst.
Johnson, B.Sc., Charles Henry (Boston Univ.),	Prescott.
Jones, B.Sc., Charles Howland (Boston Univ.),	Downer's Grove, Ill.
Moore, B.Sc., Robert Bostwick (Boston Univ.),	Framingham.
Parsons, B.Sc., Wilfred Atherton,	Southampton.
Shepardson, B.Sc., William Martin (Boston Univ.),	Warwick.
Smith, B.Sc., Frederic Jason (Boston Univ.),	North Hadley.
Smith, B.Sc., Robert Hyde (Boston Univ.),	Amherst.
Thomson, B.Sc., Henry Martin (Boston Univ.),	Monterey.
West, B.Sc., John Sherman (Boston Univ.),	Belchertown.
William, B.Sc., Frank Oliver (Boston Univ.),	Sunderland.
Total,	19

Summary.

Resident graduates,	19
Graduates of 1892,	22
Senior class,	22
Junior class,	45
Sophomore class,	39
Freshman class,	46
Total,	193
Counted twice,	3
Total,	190

FOUR YEARS' COURSE OF STUDY.

Freshman Year.

	Agriculture.	Botany and Horticulture.	Chemistry.	Natural History.	Mathematics.	Latin and English.	French and Social Science.	Drawing and Military.
Fall, . .	- - -	Botany, structural, — 5.	- - -	- - -	Advanced Algebra, — 5. Book-keeping, — 2.	Latin, — 4. English, — 2.	- -	Study of tactics, — 1.
Winter, .	History of agriculture, soils and soil formation, — 4.	- - -	- - -	- - -	Geometry, (plane and solid), — 4.	Latin, — 4. English, — 2.	- -	Free-hand drawing, — 6.
Summer, .	Improvements and characteristics of soils, drainage, etc., — 4.	Botany, analytical, — 4.	Chemistry, — 3.	- - -	Trigonometry, — 3.	Latin, — 3. English, — 2.	- -	- -

Sophomore Year.

Fall, . .	Irrigation, disposition of sewage, manures and fertilizers, — 4.	Botany, economic, — 4.	Chemistry, — 4.	- - -	Mensuration, — 2.	English, — 2.	French, — 4.	- -
Winter, .	- - -	Laboratory work, — 4.	Chemistry, — 4.	Anatomy and physiology, — 4.	- -	English, — 2.	French, — 4.	Mechanical drawing, — 5.
Summer, .	Relations of the atmosphere to farming, mowings, pastures, grasses, ensilage, — 5.	Horticulture, — 5.	Chemistry, — 3.	- - -	Surveying, — 4.	English, — 2.	French, — 3.	- -

Junior Year.

Fall, . .	Field crops, seed raising, production and improvement of varieties, machines and implements, — 4.	Market gardening, — 3.	Chemistry, — 5.	Zoölogy, laboratory work, — 8.	- -	Rhetoric and composition, — 4.	- -	- -
Winter, .	Breeds and breeding of live stock, poultry farming, — 2.	- - -	Laboratory work, — 6.	Zoölogy, — 3.	Mechanics, — 5.	- -	Eng. lit., — 4.	Drawing, — 2.
Summer, .	- - -	Landscape gardening, — 5.	Laboratory work, — 5.	Entomology, — 6.	Physics, — 4.	English, — 2.	- -	- -

* Senior Year (Elective).

Fall, . .	Dairy farming, — 5.	Botany, cryptogamic, — 3. Forestry, — 2.	Chemistry, — 5.	Entomology, — 5. Veterinary Science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1.
Winter, .	Cattle feeding, — 5.	Fungi, laboratory work, — 2. Forestry, — 3.	Chemistry, — 5.	Entomology, — 5. Veterinary Science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Political economy, — 5. German, — 5.	Military science, — 1. Law lectures, — 1.
Summer, .	Experimental work in agriculture, — 5.	Advanced botany, — 5.	Chemistry, — 5.	Entomology, — 5. Veterinary Science, — 5.	Electricity, — 5. Mathematics, — 5.	English, — 2.	Constitutional history, — 5. German, — 5.	Military science, — 1.

* English and military science are required; of the other studies three at least must be chosen.

TWO YEARS' COURSE.

Agriculture. — Lecture and text-book work in the study of soils, — formation, composition and physical character; tillage; drainage; irrigation; manures and fertilizers; farm implements and machinery, and their use; field crops; grasses and forage plants; ensilage; mowings; pastures; farm buildings; roads and fences; the breeds of cattle, sheep, horses and swine; stock breeding and feeding; dairy farming; poultry farming; markets and marketing. The work will be made as practical as possible, and will be continually illustrated in field, barns, dairy and laboratory. Many of the lectures will be of the nature of out-door talks. Practical training will be given when needed or desired. Time allotted, two hundred and twenty-two hours.

Botany. — Elementary botany, to impart general knowledge of the structure of seeds and plants, methods of reproduction and propagation, hybridization, methods of analysis of agricultural plants, especially grasses and weeds; plant diseases, and the peculiarities of trees of economical importance. Herbarium of plants of agricultural importance to be required. Time allotted, one hundred and thirty hours.

Chemistry. — Elementary chemistry; principles of the science; chemical physics; chemistry of elements important to the farmer; chemistry of soils, plants, animals, foods and fertilizers. Time allotted, one hundred and fifty hours. (No laboratory work.)

English. — Thorough drill in writing and speaking. Time allotted, two hundred and eleven hours.

Horticulture, Floriculture and Forestry. — Time allotted, one hundred and eighty-five hours.

Latin. — Elective. Designed for those intending to enter the four years' course.

Mathematics. — Algebra through quadratics; geometry, two books; trigonometry and plane surveying; topography; roads, location and construction; elementary mechanics and physics; book-keeping. Time allotted: class-room, two hundred and thirty hours; field work, ninety hours; drawing, ninety hours.

Physiology, Zoölogy and Entomology. — Time allotted, one hundred and thirty hours.

Veterinary Science. — Comparative anatomy and physiology; hygiene; treatment of emergency cases; diagnosis and treatment of simple cases. Time allotted, one hundred and eleven hours.

GRADUATE COURSE.

1. No honorary degrees shall be conferred.

2. No applicant shall be eligible to the degree of M.S. until he has received the degree of B S. or its equivalent.

3. The faculty shall offer a course of study in each of the following subjects: mathematics and physics; chemistry; agriculture and botany; entomology; veterinary. Upon the satisfactory completion of any two of these, the applicant shall receive the degree of M.S. This prescribed work, however, may be done in the Massachusetts Agricultural College, or at any institution that the applicant may choose; but in either case the degree shall be conferred only after passing an examination at the college under such rules and regulations as may be prescribed.

4. Every student in the graduate course shall pay one hundred dollars to the treasurer of the college before receiving the degree of M.S.

TEXT BOOKS.

WOOD — "The American Botanist and Florist."
BESSEY — "Botany for High Schools and Colleges."
GRAY — "Manual."
LONG — "How to Make the Garden Pay."
LONG — "Ornamental Gardening for Americans."
FULLER — "Practical Forestry."
MAYNARD — "Practical Fruit Grower."
MCALPINE — "How to know Grasses by their Leaves."
MORTON — "Soil of the Farm."
GREGORY — "Fertilizers."
MILES — "Stock Breeding."
ARMSBY — "Manual of Cattle Feeding."
FISHER — "Classbook of Elementary Chemistry."
ROSCOE — "Lessons in Elementary Chemistry."
ROSCOE AND SCHORLEMMER — "Treatise on Chemistry."
MEDICUS AND MARSHALL — "Qualitative Analysis."
WHEELER — "Medical Chemistry."
FRESENIUS — "Qualitative Chemical Analysis."
FRESENIUS — "Quantitative Chemical Analysis."
DANA — "Manual of Mineralogy and Lithology."
BRUSH — "Manual of Determinative Mineralogy."
WELLS — "College Algebra."
DANA — "Mechanics."
WENTWORTH — "Plane and Solid Geometry."
CARHART — "Surveying."

WARNER — "Mensuration."
WELLS — "Plane and Spherical Trigonometry."
ATKINSON'S Ganot's Physics.
LOOMIS — "Meteorology."
PORTER — "The Elements of Intellectual Science."
GENUNG — "The Practical Elements of Rhetoric."
WALKER — "Political Economy," abridged edition.
EMERSON — "Evolution of Expression."
LOCKWOOD — "Lessons in English."
COMSTOCK — "First Latin Book."
CÆSAR — "The Invasion of Britain."
WHITTIER, No. 4; LONGFELLOW, Nos. 33, 34, 35; LOWELL, No. 39, — "Riverside Literature Series."
SPRAGUE — "Six Selections from Irving's Sketch-book."
HUDSON — "Selections of Prose and Poetry." WEBSTER, BURKE, ADDISON, GOLDSMITH, SHAKESPEARE.
GENUNG — "Handbook of Rhetorical Analysis."
WHITNEY — "French Grammar."
KELLOGG — "English Literature."
WHITE — "Progressive Art Studies."

To give not only a practical but a liberal education is the aim in each department, and the several courses have been so arranged as to best subserve that end. Weekly exercises in composition and declamation are held throughout the course. The instruction in agriculture and horticulture is both theoretical and practical. A certain amount of labor is required of each student, and the lessons of the recitation room are practically enforced in the garden and field. Students are allowed to work for wages during such leisure hours as are at their disposal. Under the act by which the college was founded, instruction in military tactics is imperative; and each student, unless physically debarred,* is required to attend such exercises as are prescribed, under the direction of a regular army officer stationed at the college.

FOUR YEARS' COURSE.

ADMISSION.

Candidates for admission to the freshman class in 1893 will be examined, orally and in writing, upon the following subjects: English grammar, geography, arithmetic, algebra (to quadratic equations, including radicals), the metric system and the history of the United States. The standard required is sixty-five per

* Certificates of disability must be procured of Dr. Herbert B. Perry of Amherst.

cent on each paper. Diplomas from high schools will not be received in place of examination.

Candidates for higher standing are examined as above, and also in the studies gone over by the class to which they desire admission.

No one can be admitted to the college until he is fifteen years of age. Every applicant is required to furnish a certificate of good character from his late pastor or teacher. The regular examinations for admission are held at the Botanic Museum, at nine o'clock A.M., on Thursday, June 22, and on Tuesday, September 5; but candidates may be examined and admitted at any other time in the year. For the accommodation of those living in the eastern part of the State, examinations will also be held at nine o'clock A.M., on Thursday, June 22, at Jacob Sleeper Hall, Boston University, 8 Somerset Street, Boston; and for the accommodation of those in the western part of the State, at the same date and time, at the Sedgwick Institute, Great Barrington, by James Bird.

Increased Requirements.

After 1893, candidates for admission to the freshman class will be examined in English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), civil government (Mowry's "Studies in Civil Government"), and Latin (grammar and first ten chapters of the first book of Cæsar's "Gallic War," or an equivalent).

Age for admission, sixteen years. Diplomas from high schools will not be received in place of examinations.

TWO YEARS' COURSE.

Calendar the same as in the four years' course. Age for admission, fifteen years. The objects of this course are, primarily, to help farmers' sons and others proposing to follow some branch of agriculture, who lack either the time or the means required for the longer course; secondly, in so far as practicable to serve as a preparation for the regular college course.

Admission.

Candidates for admission are examined orally and in writing in English grammar, geography, arithmetic and United States history. The standard required is sixty-five per cent on each paper.

ENTRANCE EXAMINATION PAPERS USED IN 1892.

Arithmetic.

1. Define quantity, and give examples of concrete and abstract numbers.

2. Find the greatest common divisor of 30, 110, 140, and 680.

3. Add together $\frac{7}{8}$, $\frac{1}{12}$, $\frac{17}{18}$, $\frac{23}{24}$, and $\frac{29}{27}$.

4. When $\frac{3}{8}$ of an acre of land cost $75, what will $7\frac{4}{5}$ acres cost?

5. What part of 1 t. 6 cwt. 15 lb. 10 oz. is 10 cwt. 46 lb. 4 oz.?

6. Bought a horse for $250, paid for keeping him $10, and sold him for $234; what was the loss per cent.?

7. Find the amount of $1,234 50 for 8 years 9 months 10 days at $7\frac{3}{10}$ per cent.

8. What is the difference between the interest and true discount of $1,050, due 10 months hence, at 6 per cent.?

9. Define *ratio* and *proportion*, and solve the following problem: If 6 men can mow 16 acres in 4 days, how long will it take 10 men to mow 40 acres at the same rate?

10. Extract the square root of 3,164.0625.

Metric System.

1. How is the metric system formed?

2. How are the lower denominations of each weight or measure expressed? The higher denominations?

3. Name the principal units of the metric system and give their equivalents.

4. Give the table for liquid or dry measure.

5. How many hectoliters of oats can be put into a bin that is 4 meters long, $3\frac{6}{10}$ meters wide, and $2\frac{5}{10}$ meters deep?

6. The produce per hectare being 10 hectoliters, what is it per acre?

7. In 40 metric tons how many tons?

8. When the distance between two places is $31\frac{5}{10}$ kilometers, how many miles are they apart?

9. Write the table for long measure.

10. In 3 lbs. 8 oz. 18 pwt. of gold how many grams?

Algebra.

1. Define algebra, coefficient, exponent, and name four kinds of symbols used in algebra.

2. Name three methods of elimination.

3. Factor the following expressions: —

$$x^2 - 14x + 49,\ x^3 - y^3,\ 64x^6 - 1.$$

4. Find the common divisor of $4x^2 - 4x + 1$, $4x^2 - 1$, and $8x^3 - 1$.

5. Reduce to its simplest form $\frac{6x^2+x-35}{8x^2+22x+5}$ and $\frac{10x^2-x-21}{2x^2-7x+6}$

6. Solve: $\frac{x}{3}-\frac{x^2-5x}{3x-7}=\frac{2}{3}$.

7. A and B can do a piece of work in 7 days which A alone can do in 10 days; in what time could B alone do it?

8. Extract the cube root of $1-6y+12y^2-8y^3$.

9. Add together $\sqrt[3]{\frac{1}{4}}$, $\sqrt[3]{\frac{1}{32}}$, and $\sqrt[3]{\frac{2}{3}}$.

10. Solve:

$$\sqrt{2x-3}-\sqrt{8x+1}+\sqrt{18x-92}=0.$$

Grammar and Composition.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper. State whether you have studied Latin. If you have studied it, state how long and what you have read.

1. What is English grammar? Into what parts is it commonly divided?

2. Write a sentence that shall have a pronoun in the objective case, an adjective in the comparative degree, and an adverb of manner.

3. Write the possessive singular and plural of the following: lady, thief, tooth, I, it, hero, money, child, sheep, trout.

4. Name the principal and subordinate clause in the following sentence: "What cost the British nation eight millions sterling, a succession of campaigns and many lives, was won in ten minutes by a few undisciplined men, without the loss of life or limb."

5. Write the titles of any three books you have read since June 1, 1891. Write at least one hundred words on one of the following subjects: (*a*) Any topic suggested by what you have read in the books just named. (*b*) An outline of any character described in any one of these books. (*c*) The industries of Massachusetts.

6. Change the following to connected prose: —

So all night long the storm roared on:
The morning broke without a sun;
In tiny spherule traced with lines
Of Nature's geometric signs,
In starry flake and pellicle,
All day the hoary meteor fell;
And, when the second morning shone,
We looked upon a world unknown,
On nothing we could call our own.
Around the glistening wonder bent
The blue walls of the firmament.
No cloud above, no earth below,—
A universe of sky and snow!

7. Write sentences illustrating the correct use of the following: —

(*a*) Differ *from* and differ *with*.
(*b*) Divide *between* and divide *among*.
(*c*) Concur *with* and concur *in*.

8. Correct the following: —

(*a*) If he don't come, be sure and let me know.
(*b*) It's part of your duty to learn them how to do it.
(*c*) I have no doubt but what he felt kind of disappointed.
(*d*) The mud on the streets was perfectly awful.
(*e*) I never want to be in the same fix again.
(*f*) All I've got to say is that I will be very surprised if he don't pass.

Geography.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. What is the equator? a meridian? longitude? What is the greatest longitude a place can have? Why?

2. What is a mountain-system? a watershed? What is the distinction between a cape and a promontory?

3. What is the atmosphere? Which parts of the atmosphere are the densest? Why? Which parts are the warmest? Why?

4. Name the six grand divisions of the earth in the order of their size; the six largest islands and the location of each.

5. Bound the United States, exclusive of Alaska. What separates Alaska from the rest of the United States? Name the political divisions of South America.

6. Draw an outline map of Massachusetts, and locate three important rivers found, wholly or in part, in the State. Draw an outline map of the county in which you live, and locate the county-seat.

7. Name the great lakes. What States border on each? Where is the National Park?

8. In which State and on what water is each of these cities located: Brooklyn? Cleveland? Louisville? Pittsburg? Milwaukee? Lowell? Burlington? Minneapolis? Cairo? Omaha?

9. Under which national government are the following: Canton? Lyons? Belfast? Marseilles? Kioto? Milan? Madras? Glasgow? Odessa? Havana?

10. In which country are the following, and for what are they noted: Minneapolis? Dresden? Smyrna? Fez? Naples? Rome?

United States History.

Note. — Penmanship, spelling, capitalization, and punctuation will be considered in determining the excellence of your paper.

1. Distinguish between Pilgrims and Puritans. What colonies were founded within the present limits of the State of Massachusetts?

2. What three kinds of colonial governments were there? Name the colonies that were under each.

3. Who was the first governor of the State of Massachusetts? Who is the present governor? In what is the legislative power of the State vested?

4. What was the principal cause of the war of 1812? of the Mexican war? What persons having part in the latter war became presidents of the United States?

5. Name the written compact or State paper connected with each of the following dates: 1620, 1776, 1787, 1863.

6. What were the articles of confederation? When did the constitutional form of government go into effect? Write in full the names of the thirteen original States.

7. Name the most important events of the administration of William Henry Harrison; of that of Benjamin Harrison.

8. How many Representatives in Congress has Massachusetts? How many United States Senators are there? Who is the President of the United States Senate?

9. What important event in United States History is to be associated with each of the following: Hadley, Concord, Gettysburg, Long Island, Harper's Ferry, Chicago, Cambridge, New York.

10. Name the three most important battle-fields within the limits of the United States, and your reasons for naming them.

DEGREES.

Those who complete the four years' course receive the degree of Bachelor of Science, the diploma being signed by the governor of Massachusetts, who is president of the corporation.

Regular students of the college may also, on application, become members of Boston University, and upon graduation receive its diploma in addition to that of the college, thereby becoming entitled to all the privileges of its alumni.

A diploma will be awarded to those completing the two years' course. Those completing the graduate course receive the degree of Master of Science.

EXPENSES.

Tuition, in advance: —			
Fall term,	$30 00		
Winter term,	25 00		
Summer term,	25 00	$80 00	$80 00
Room rent, in advance, $8 to $16 per term,		24 00	48 00
Board, $2.50 to $5 per week,		95 00	190 00
Fuel, $5 to $15,		5 00	15 00
Washing, 30 to 60 cents per week,		11 40	22 80
Military suit,		15 75	15 75
Expenses per year,		$231 15	$371 55

Board in clubs has been two dollars and forty-five cents per week; in private families, four or five dollars. The military suit must be obtained immediately upon entrance at college, and used in the drill exercises prescribed. For the use of the laboratory in practical chemistry there will be a charge of ten dollars per term used, and also a charge of four dollars per term for the expenses of the zoölogical laboratory. Some expense will also be incurred for lights and for text books. Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the senator of the district in which they live.

THE LABOR FUND.

The object of this fund is to assist those students who are dependent either wholly or in part on their own exertions, by furnishing them work in the several departments of the college. The greatest opportunity for such work is found in the agricultural and horticultural departments. Application should be made to Professors Wm P. Brooks and Samuel T. Maynard, respectively, in charge of said departments. Students desiring to avail themselves of its benefits must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

ROOMS.

All students, except those living with parents or guardians, will be required to occupy rooms in the college dormitories.

For the information of those desiring to carpet their rooms, the following measurements are given: in the new south dormitory

the study rooms are about fifteen by fourteen feet, with a recess seven feet four inches by three feet; and the bedrooms are eleven feet two inches by eight feet five inches. This building is heated by steam. In the north dormitory the corner rooms are fourteen by fifteen feet, and the annexed bedrooms eight by ten feet. The inside rooms are thirteen feet and one-half by fourteen feet and one-half, and the bedrooms eight by eight feet. A coal stove is furnished with each room. Aside from this, all rooms are unfurnished. Mr. Thomas Canavan has the general superintendence of the dormitories, and all correspondence relative to the engaging of rooms should be with him.

SCHOLARSHIPS.

Established by Private Individuals.

Mary Robinson Fund of one thousand dollars, the bequest of Miss Mary Robinson of Medfield.

Whiting Street Fund of one thousand dollars, the bequest of Whiting Street, Esq., of Northampton.

Henry Gassett Fund of one thousand dollars, the bequest of Henry Gassett, Esq., of North Weymouth.

The income of the above funds is assigned by the faculty to worthy students requiring aid.

CONGRESSIONAL SCHOLARSHIPS.

The trustees voted in January, 1878, to establish one free scholarship for each of the congressional districts of the State. Application for such scholarships should be made to the representative from the district to which the applicant belongs. The selection for these scholarships will be determined as each member of Congress may prefer; but, where several applications are sent in from the same district, a competitive examination would seem to be desirable. Applicants should be good scholars, of vigorous constitution, and should enter college with the intention of remaining through the course, and then engaging in some pursuit connected with agriculture.

STATE SCHOLARSHIPS.

The Legislature of 1883 passed the following Resolve in favor of the Massachusetts Agricultural College: —

Resolved, That there shall be paid annually, for the term of four years, from the treasury of the Commonwealth to the treasurer of the

Massachusetts Agricultural College, the sum of ten thousand dollars, to enable the trustees of said college to provide for the students of said institution the theoretical and practical education required by its charter and the law of the United States relating thereto.

Resolved, That annually, for the term of four years, eighty free scholarships be and hereby are established at the Massachusetts Agricultural College, the same to be given by appointment to persons in this Commonwealth, after a competitive examination, under rules prescribed by the president of the college, at such time and place as the senator then in office from each district shall designate; and the said scholarships shall be assigned equally to each senatorial district. But, if there shall be less than two successful applicants for scholarships from any senatorial district, such scholarships may be distributed by the president of the college equally among the other districts, as nearly as possible; but no applicant shall be entitled to a scholarship unless he shall pass an examination in accordance with the rules to be established as hereinbefore provided.

The Legislature of 1886 passed the following Resolve, making perpetual the scholarships established: —

Resolved, That annually the scholarships established by chapter forty-six of the Resolves of the year eighteen hundred and eighty-three be given and continued in accordance with the provisions of said chapter.

In accordance with these resolves, any one desiring admission to the college can apply to the senator of his district for a scholarship. Blank forms of application will be furnished by the president.

EQUIPMENT.

Agricultural Department.

The Farm. — Among the various means through which instruction in agriculture is given, none exceeds in importance the farm. The part which is directly under the charge of the professor of agriculture comprises about one hundred and fifty acres of improved land and thirty acres of woodland. Of the improved land, about thirty acres are kept permanently in grass, and managed partly with a view to landscape effect. A considerable share of this land is, however, laid off in half and quarter acre plats, and variously fertilized with farm-yard and stable manures and chemicals, with a view to throwing light upon the economical production of grass. These plats are staked and labeled, so that all may see exactly what is being used and what are the results.

The balance of the farm is managed under a system of rotation, all parts being alternately in grass and hoed crops. All the ordinary crops of this section are grown, and many not usually seen

upon Massachusetts farms find a place here. Our large stock of milch cows is almost entirely fed in the barn, and fodder crops occupy a prominent place. Experiments of various kinds are continually under trial; and every plat is staked and bears a label stating variety under cultivation, date of planting and manures and fertilizers used.

Methods of land improvement are constantly illustrated here, tile drainage especially receiving a large share of attention. There are now some nine miles of tile drains in successful and very satisfactory operation upon the farm. Methods of clearing land of stumps are also illustrated, a large amount of such work having been carried on during the last few years.

In all the work of the farm the students are freely employed, and classes are frequently taken into our fields; and to the lessons to be derived from these fields the students are constantly referred.

The Barn and Stock. — Our commodious barns contain a large stock of milch cows, many of which are grades; but the following pure breeds are represented by good animals, viz., Holstein-Friesian, Ayrshire, Jersey, Guernsey and Shorthorn. Experiments in feeding for milk and butter are continually in progress.

We have a fine flock of Southdown sheep; swine are represented by the Small Yorkshire and Tamworth breeds; and besides work-horses we have a number of pure-bred Percherons used for breeding as well as for work. The barn is equipped with a view to illustrating different methods of fastening animals, styles of mangers, etc. Connected with it is an engine room, storage rooms for vehicles, machinery and tools, and a granary. It contains three silos and a root cellar.

A very large share of the work in the barn is performed by students, and whenever points require illustration classes are taken to it for that purpose.

Dairy Room. — Connected with the farm-house is a model dairy room, containing Cooley creamers, by means of which our cream is for the most part raised. We are provided also with milk coolers and aerators of several patterns, churns, separator, butter workers, etc. The various processes connected with the creaming of milk, the preparation of milk for market and the manufacture of butter are illustrated here before our classes.

Equipment of Farm. — Aside from machines and implements generally found upon farms, the more important of those used upon our farm and in our barn which it seems desirable to mention are the following: reversible sulky plough, grain drill, horse corn planter, potato planter, hay loader, potato digger, hay press, fodder cutter and crusher, and grain mill. It is our aim to try all

novelties as they come out, and to illustrate everywhere the latest and best methods of doing farm work.

Lecture Room. — The agricultural lecture room in south college is well adapted to its uses. It is provided with numerous charts and lantern slides, illustrating the subjects taught. Connected with it are two small rooms at present used for the storage of illustrative material, which comprises soils in great variety, all important fertilizers and fertilizer materials, implements used in the agriculture of our own and other countries, and a collection of grasses and forage plants, grains, etc.

Museum. — An important beginning has been made towards accumulating materials for an agricultural museum. This is to contain the rocks from which soils have been derived, soils, fertilizer materials and manufactured fertilizers, seeds, plants and their products, stuffed animals, machines and implements. It is expected to make this collection of historical importance by including in it old types of machines and implements, earlier forms of breeds, etc. For lack of room, the material thus far accumulated, which is considerable, is stored in a number of scattered localities, and much of it where it cannot be satisfactorily exhibited.

Botanic Department.

The equipment of the botanic department has been collected for the twofold purpose of supplementing instruction in the science of botany and in the various lines of horticultural work, as fruit culture, market gardening, forestry, floriculture and landscape gardening.

For teaching botany proper, the equipment is as follows: —

The Botanic Museum, containing the Knowlton Herbarium, of over ten thousand species and varieties of phanerogamous and the higher cryptogamous plants, over two thousand species of fungi and several collections of lichens and mosses. It also contains a large collection of native woods, cut so as to show their individual structure; numerous models of native fruits; specimens of abnormal and peculiar forms of stems, fruit, vegetables, etc.; many interesting specimens of unnatural growths of trees and plants, natural grafts, etc.; together with many specimens and models prepared for illustrating the growth and structure of plants, and including a model of the "giant squash," which raised by the expansive force of its growing cells the enormous weight of five thousand pounds.

The Botanic Lecture Room, in the same building, is provided with diagrams and charts of over three thousand figures, illustrating structural and systematic botany.

The Botanic Laboratory, with provision for twenty-five students to work at one time, is equipped with twenty-three compound microscopes, including the makes of R. B. Tolles, J. W. Queen & Co., R. & J. Beck and Bausch & Lomb, with objectives ranging from four-inch to one-fifteenth inch focal lengths, and all the accessory apparatus requisite for a thorough study of plant structure and plant physiology. Special attention is here given to the study of the common and useful plants cultivated on the farm, in the garden and under glass. Apparatus for photographing microscopic sections and other objects, and special books needed for reference by the students while at work in the laboratory, are soon to be added.

Greenhouses. — To aid in the instruction of botany as well as that of floriculture and market gardening, the glass structures contain a large collection of plants of a botanical and economic value, as well as those grown for commercial purposes. They consist of a large octagon, forty by forty feet, with sides twelve feet high and a central portion over twenty feet high, for the growth of large specimens, like palms, tree ferns, the bamboo, banana, guava, olive, etc ; a lower octagon, forty by forty feet, for general greenhouse plants; a moist stove, twenty-five by twenty-five feet; a dry stove, twenty-five by twenty-five feet; a rose room, twenty-five by twenty feet; a room for aquatic plants, twenty by twenty-five feet; a room for ferns, mosses and orchids, eighteen by thirty feet; a large propagating house, fifty by twenty-four feet, fitted up with benches sufficient in number to accommodate fifty students at work at one time; a vegetable house, forty-two by thirty-two feet; two propagating pits, eighteen by seventy-five feet, each divided into two sections for high and low temperatures, and piped for testing overhead and under-bench heating. To these glass structures are attached three work-rooms, equipped with all kinds of tools for greenhouse work. In building these houses as many as possible of the principles of construction, heating and ventilating, etc., have been incorporated for purposes of instruction.

For instruction in horticulture are : —

Orchards. — The orchards are extensive, and contain nearly all the valuable leading varieties, both old and new, of the large fruits, growing under various conditions of soil and exposure.

Small Fruits. — The small fruit plantations contain a large number of varieties of each kind, especially the new and promising ones, which are compared with older sorts, in plots and in field culture. Methods of planting, pruning, training, cultivation, study of varieties, gathering, packing and shipping fruits, etc., are

taught by field exercises, the students doing a large part of the work of the department.

Nursery. — This contains more than five thousand trees, shrubs and vines, in various stages of growth, where the different methods of propagation by cuttings, layers, budding, grafting, pruning and training are practically taught to the students.

Garden. — All kinds of garden and farm-garden crops are grown in this department, furnishing ample illustration of the treatment of all market garden crops. The income from the sales of trees, plants, flowers, fruit and vegetables aids materially in the support of the department, and furnishes illustrations of the methods of business, with which all students are expected to become familiar.

Forestry. — Many kinds of trees suitable for forest planting are grown in the nursery, and plantations have been made upon the college grounds and upon private estates in the vicinity, affording good examples of this most important subject. A large forest grove is connected with this department, where the methods of pruning trees and the management and preservation of forests can be illustrated. In the museum and lecture room are collections of native woods, showing their natural condition and peculiarities; and there have been lately added the prepared wood sections of R. B. Hough, mounted on cards for class room illustrations.

Ornamental trees, shrubs and flowering plants are grouped about the grounds in such a way as to afford as much instruction as possible in the art of landscape gardening. All these, as well as the varieties of large and small fruits, are marked with conspicuous labels, giving their common and Latin names, for the benefit of the students and the public.

Tool House. — A tool house, thirty by eighty feet, has just been completed, containing a general store-room for keeping small tools, a repair shop with forge, anvil and work bench, and open sheds for housing wagons and large tools. Under one-half of this building is a cellar for storing fruit and vegetables. In the loft is a chamber, thirty by eighty feet, for keeping the hotbed sashes, shutters, mats, berry crates, baskets and other materials when not in use.

Connected with the stable is a cold-storage room, with an ice chamber over it, for preserving fruit, while the main cellar underneath the stable is devoted to the keeping of vegetables.

The great need of this department is funds with which to purchase manures and fertilizers for keeping the grounds and orchards in a satisfactory condition of growth. A part of the garden land south of the greenhouses sadly needs underdraining, and at a

small expense could be put into a condition for profitable cultivation.

A Massachusetts Garden.

The proposition to devote the hillside in the south-east corner of the farm to the growth of the trees and plants of Massachusetts is one that should be carried out, thus adding a very useful as well as beautiful feature to the grounds.

The location of the college is one of the most beautiful to be found in the State, and the ornamentation of the banks of the beautiful sheet of water between the botanic department and the main college buildings, as well as the hillside above the greenhouses, will do more than any one thing to make the college grounds noted for their finished beauty as a combination of art and nature.

ZOÖLOGICAL DEPARTMENT.

Zoölogical Lecture Room. — This room, in south college, is well adapted for lecture and recitation purposes, and is supplied with a series of zoölogical charts prepared to order, also a set of Leuckart's charts, disarticulated skeletons, and other apparatus for illustrating the lectures in the class-room.

Zoölogical Museum. — This is in immediate connection with the lecture room, and contains the Massachusetts State collection, which comprises a large number of mounted mammals and birds, together with a series of birds' nests and eggs, a collection of alcoholic specimens of fishes, reptiles and amphibians, and a collection of shells and other invertebrates.

There is also on exhibition in the museum a collection of skeletons of our domestic and other animals, and mounted specimens purchased from Prof. H. A. Ward; a series of glass models of jelly fishes, worms, etc., made by Leopold Blaschka in Dresden; a valuable collection of corals and sponges from Nassau, N. P., collected and presented by Prof. H. T. Fernald; a fine collection of corals, presented by the Museum of Comparative Zoölogy in Cambridge; a collection of alcoholic specimens of invertebrates from the coast of New England, presented by the National Museum at Washington; a large and rapidly growing collection of insects of all orders, and a large series of clastique models of various animals, manufactured in the Auzoux laboratory in Paris. The museum is now open to the public from three to four P.M. every day except Saturday and Sunday.

Zoölogical Laboratory. — A large room in the laboratory building has been fitted up for a zoölogical laboratory, with tables, sink, gas, etc., and is supplied with a reference library, micro-

scopes, chemical and other necessary apparatus for work. This laboratory with its equipment is undoubtedly the most valuable appliance for instruction in the department of zoölogy.

Veterinary Department.

This department is well equipped with the apparatus necessary to illustrate the subject in the class room.

It consists of an improved Auzoux model of the horse, imported from Paris, constructed so as to separate and show in detail the shape, size, structure and relations of the different parts of the body; two papier maché models of the hind legs of the horse, showing disease of the soft tissues, — wind-galls, bogs, spavins, etc., also the diseases of the bone tissues, splint, spavins and ring-bones; two models of the foot, one according to Bracy Clark's description, the other showing the Charlier method of shoeing and the general anatomy of the foot; a full-sized model of the bones of the hind leg, giving shape, size and position of each individual bone.

There is an articulated skeleton of the famous stallion, Black-hawk; a disarticulated one of a thorough-bred mare, besides one each of the cow, sheep, pig and dog; two prepared dissections of the fore and hind legs of the horse, showing the position and relation of the soft tissues to the bones; a papier maché model of the uterus of the mare and of the pig; a gravid uterus of the cow; a wax model of the uterus, placenta and fœtus of the sheep, showing the position of the fœtus and the attachment of the placenta to the walls of the uterus.

In addition to the above there is a growing collection of pathological specimens of both the soft and osseous tissues, and many parasites common to the domestic animals. A collection of charts and diagrams especially prepared for the college is used in connection with the lectures upon the subject of anatomy, parturition and conformation of animals.

Through the kindness of Mr. Henry Adams of Amherst the department has received a large sample collection of the various drugs used in the treatment of the diseases of the domestic animals.

For the benefit of the students, sick or diseased animals are frequently shown them, and operations performed in connection with the class-room work. For the use of the instructor of this department a laboratory has been provided in the old chapel building. It has been equipped with the apparatus necessary for the study of histology, pathology and bacteriology, consisting in part of an improved Zeiss microscope with a one-eighteenth inch objec-

tive, together with the lower powers; a Lautenschläger's incubator and hot-air sterilizer; an Arnold's steam sterilizer and a Bausch and Lomb improved laboratory microtome. This apparatus is used for the preparation of material for the class room and for general investigation.

Mathematical Department.

The instruction embraces pure mathematics, civil engineering, mechanics and physics. For civil engineering there are an Eckhold's omnimeter, solar transit, three engineer's transits, surveyor's transit, gradienter, plane table, two common compasses, two levels, one architect's compass level, six surveyor's chains, six levelling rods of various patterns, cross-section rod, and such other incidental apparatus as is necessary for practical field and railroad work.

For mechanics there is a full set of mechanical powers, and a good collection of apparatus for illustration in hydrostatics, hydrodynamics and pneumatics. There is also a supply of physical apparatus for illustrating the general principles of sound, heat and light.

For practical study in electricity there are several electrical machines; small hand dynamo with complete outfit of necessary apparatus, coils, standard one thousand ohm resistance box, Wheatstone's bridge, testing set, sine and tangent galvanometer, Thomson's reflecting galvanometer with shunt box and standard scale, electrometer, direct reading voltmeter and ammeter, and a large quantity of less expensive but important apparatus for class-room illustration and laboratory work. Much of this collection is new, having been recently added, and thus the facilities for practical information in this department have been greatly increased.

Adjacent to the commodious lecture room are a battery room and the physical cabinet.

Chemical Department.

Instruction in general, agricultural and analytical chemistry and mineralogy is given in the laboratory building.

The Lecture Room, on the second floor, is large and commodious. Immediately adjoining it are four smaller rooms, which serve for storing apparatus and preparing material for the lecture table.

The Laboratory for beginners is a capacious room on the first floor. It is well lighted and ventilated, and furnished with forty working tables. Each table is provided with sets of reagents (wet and dry), a fume chamber, water, gas, drawer and locker. The laboratory for advanced students has eight tables, and is well

equipped for work. A balance room, furnace room and supply room adjoin the laboratory.

Apparatus and Collections. — Large additions have recently been made to the apparatus. Deficiencies caused by the wear and breakage of several years have thus been supplied, and the original outfit considerably increased. The various rooms are supplied with an extensive collection of industrial charts, including Lenoir and Foster's series, balances, microscope, spectroscope, polariscope and numerous models and sets of apparatus. A valuable and growing collection of specimens and samples fitted to illustrate different subjects is also provided. This includes rocks, minerals, soils, raw and manufactured fertilizers; foods, including milling products; fibres and other vegetable and animal products, and artificial preparations of mineral and organic compounds.

Military Department.

United States Property.

2 light twelve-pound bronze guns with implements.
2 eight-inch mortars with implements.
2 gun carriages.
2 mortar beds.
127 Springfield cadet rifles.
125 infantry accoutrements, sets.
31 headless shell extractors.
10,000 metallic ball cartridges.
1,600 metallic blank cartridges.
4,000 pasters.
125 targets, A and B.

Library.

This now numbers 13,050 volumes, having been increased during the year, by gift and purchase, 2,468 volumes. It is placed in the lower hall of the new chapel-library building, and is made available to the general student for reference or investigation. It is especially valuable as a library of reference, and no pains will be spared to make it complete in the departments of agriculture, horticulture and botany, and the natural sciences. It is open a portion of each day for consultation, and an hour every evening for the drawing of books.

PRIZES.

Rhetorical Prizes.

The prizes heretofore offered by Isaac D. Farnsworth, Esq., will this year be given by the Western Alumni Association of the

Massachusetts Agricultural College. These prizes are awarded for excellence in declamation, and are open to competition, under certain restrictions, to members of the sophomore and freshman classes.

Military Prize.

A prize of fifteen dollars for the best essay on some military subject is offered this year to the graduating class by John C. Cutter, '72, and Charles H. Southworth, '77.

Flint Prizes.

Mr. Charles L. Flint of the class of 1881 has established two prizes, one of thirty dollars and another of twenty dollars, to be awarded, at an appointed time during commencement week, to the two members of the junior class who may produce the best orations. Excellence in both composition and delivery is considered in making the award.

Mathematical Prize.

A prize of fifty dollars is offered to that member of the senior class who shall pass the best written examination in the mathematics of the regular course.

Grinnell Agricultural Prizes.

Hon. William Claflin of Boston has given the sum of one thousand dollars for the endowment of a first and second prize, to be called the Grinnell Agricultural prizes, in honor of George B. Grinnell, Esq., of New York. These two prizes are to be paid in cash to those two members of the graduating class who may pass the best oral and written examination in theoretical and practical agriculture.

Hills Botanical Prizes.

For the best herbarium collected by a member of the class of 1893, fifteen dollars is offered, and for the second best a prize of ten dollars; also a prize of five dollars for the best collection of woods, and a prize of five dollars for the best collection of dried plants from the college farm.

The prizes in 1892 were awarded as follows: —

Fowler Rhetorical Prizes, — Archie H. Kirkland (1894), first; George H. Merwin (1894), second; Robert A. Cooley (1895), first; Frank L. Warren (1895), second.

Grinnell Agricultural Prizes. — Henry M. Thomson (1892), first; Henry B. Emerson (1892), second.

Hills Botanical Prizes. — Edward T. Clark (1892), first; Robert

H. Smith (1892), second. Collection of native woods, Henry M. Thomson (1892); dried plants from the college farm, Frank H. Plumb (1892).

RELIGIOUS SERVICES.

Students are required to attend prayers every week-day at 8.15 A.M., and public worship in the chapel every Sunday at 10.30 A.M., unless, by request of their parents, arrangements are made to attend divine service elsewhere. Further opportunities for moral religious culture are afforded by a Bible class taught at the close of the Sunday morning service, and by religious meetings held on Sunday afternoon and during the week, under the auspices of the college Young Men's Christian Association.

LOCATION.

Amherst is on the New London Northern Railroad, connecting at Palmer with the Boston & Albany Railroad, and at Miller's Falls with the Fitchburg Railroad. It is also on the Central Massachusetts Railroad, connecting at Northampton with the Connecticut River Railroad and with the New Haven and Northampton Railroad.

The college buildings are on a healthful site, commanding one of the finest views in New England. The large farm of three hundred and eighty-three acres, with its varied surface and native forests, gives the student the freedom and quiet of a country home.

APPENDIX.

FACTS FOR FARMERS.

AGRICULTURAL.

WILLIAM P. BROOKS.

Division First. — Fertilizers.

1. Fodder crops, pasture grasses, corn stover and hay all remove large amounts of potash from the soil, and these crops occupy a large proportion of our improved lands.

2. The urine of our domestic animals contains about four-fifths of the total potash of their excrements.

3. When urine is allowed to waste, the manure is poor in potash.

4. When manures are exposed to rains, much of the potash, being soluble, is washed away.

5. Nearly all special fertilizers are especially rich in phosphoric acid, and do not contain enough potash.

6. Superphosphates were the first fertilizers to come into general use among our farmers.

7. When the farmer buys a fertilizer, he still, nine times out of ten, calls for a phosphate.

8. As a result of the above conditions, our soils seem to be quite generally in need of more liberal applications of potash.

9. In the case of corn the need of potash appears to be particularly prominent.

10. For a good crop of corn the fertilizer used should supply one hundred to one hundred and twenty-five pounds of actual potash per acre; two hundred to two hundred and fifty pounds of muriate of potash or one ton of good wood ashes will do this.

11. With ordinary farm or stable manure it will generally pay to use some potash for this crop; 125 to 150 pounds of muriate of potash has given profitable results.

12. The liberal use of potash means more clover in our fields, more nitrogen taken from the air, more milk in the pail, a richer manure heap, and store-houses and barns full to overflowing. It means also a sod which when turned will help every other crop.

13. For the potato crop the sulphate appears to be much superior to the muriate of potash, promoting both yield and quality

in much higher degree; three hundred to four hundred pounds of high-grade sulphate of potash furnishes enough of this element.

14. For oats, rye and grass, nitrate of soda applied just as growth begins in spring has proved very beneficial; three hundred to four hundred pounds per acre should be applied.

Division Second. — Silage *versus* Mangolds.

1. *Thirty pounds* of corn silage (made from Longfellow corn when glazed), fed in connection with grain, hay and stover, has proved more valuable for milk production than *forty pounds* of yellow globe mangolds fed in the same manner. The *silage* has given more milk and more cream, and the cows have *gained weight* when receiving it and *lost weight* when getting the beets.

2. Even under conditions the most favorable for the beets, it costs about one and a half times as much to place them before the cow as it does to place before her an equal quantity of the best corn silage.

3. The beet crop is a far more uncertain one than corn.

4. In view of the above facts, the superior economy of corn for the silo as a food for milk production is evident.

Division Third. Corn Stover.

1. Chemists have long told us that well-cured corn stover is almost equal in feeding value to the best English hay.

2. It has been found impossible without cooking to get *well-fed* cows to eat more than about one-half of stover, even when cut.

3. Machines which crush or shred as well as cut stover have removed this difficulty. Highly fed cows eat crushed stover clean, and give most satisfactory results at the pail. The advantage to the pocket-book is evident.

4. There are raised annually in Massachusetts about 54,000 acres of corn. This must yield about 81,000 tons of stover.

5. If this is worth $8.00 a ton for feeding, and on the average about one-half of it is wasted, the annual net loss to the farmers of this State is about $285,000.

6. This might be saved at an expense of about $40,000, as it should cost only about a dollar per ton to crush the stover.

The full food value of the part uneaten would be $324,000; the full manurial value, according to Dr. Goessmann, is $190,700. By feeding we lose only one-fifth of the manurial value, and hence from $324,000 I deduct one-fifth of $190,700.

MATHEMATICAL AND METEOROLOGICAL.

CLARENCE D. WARNER.

Measurement of Land.

To find the number of acres in any rectangular piece of land: —

Rule. — Multiply the length and breadth in rods together, and divide by 160 (the number of square rods in an acre), and the result will be the required answer.

To find the number of acres in any rectangular piece of land: —

(*a*) When one side and perpendicular to that side from the opposite angle are given.

Rule. — Take one-half the product of the side and perpendicular, and divide by 160.

(*b*) When three sides are given.

Rule. — From half the sum of the three sides subtract each side separately; multiply the half sum and the three remainders together; the square root of the product divided by 160 will give the number of acres in the field.

(*c*) When the piece of land is in the shape of a trapezoid.

Rule. — Take one-half the product of the sum of the parallel sides and the perpendicular between those sides, and divide by 160.

To find the area of any rectilineal piece of land, divide the latter into convenient parts, find the area of every part, and the sum will be the area of the field.

In general, the parts into which the field can be most conveniently divided will all be triangles, but in some cases we may have a rectangle or a trapezoid, whose areas may be found by the preceding rules.

Hay Measure.

How to weigh a haystack: —

Rule. — Measure the length and breadth of the stack, take height from the ground to the eaves, add to this last one-half of

the height from the eaves to the top, multiply the length by the breadth and the product by the height (all expressed in feet), divide the amount by 27, to find the cubic yards, which multiply by the number of pounds supposed to be in a cubic yard; namely, in a stack of new hay 132 pounds average each, if old hay, 154 pounds each.

To find the cost of a load of hay or straw: —

Rule. — Multiply the price per ton by the number of pounds in the load and divide the product by 2,000, and the result will be the required answer.

The same rule applies to coal and all commodities sold by the ton.

Grain Measure.

To measure grain in bulk: —

Rule. — Multiply the width and length of the pile together, and that product by the height, and divide by 2,150.42 (the number of cubic inches in a bushel), and you have the contents in bushels.

If you wish to find the contents of a pile of ears of corn or roots, in heaped bushels, ascertain the cubic inches, and divide by 2,818.

To measure grain in the bin: —

Rule. — Find the contents of the bin in cubic feet, then diminish the contents by one-fifth, and the result will be the contents in bushels.

The preceding is a convenient rule, and very nearly correct.

To find the dimensions of a bin which shall contain a given number of bushels: —

Rule. — Increase the number of bushels one-fifth the number of itself, and the result will show the number of cubic feet which the bin will contain; then, when two dimensions of the bin are known, divide the last result by their product, and the quotient will be the other dimension.

To measure corn in the crib: —

Rule 1. — Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get the quantity of shelled corn in a crib, measure the length, breadth and height of the crib (inside the walls), and multiply the length by the breadth and the product by the height, and divide the result by 2, and you have the number of bushels of shelled corn in the crib. (This rule applies to a crib of any size or kind.)

[Note. — In measuring the height, of course the height of the corn is intended. There will be a difference in measuring corn in this mode between fall and spring, because it shrinks very much during the winter, and consequently settles.]

Rule 2. — Find the number of cubic feet in the crib, multiply

this by 4 and divide the product by 9. This allows $2\frac{1}{4}$ cubic feet for a bushel. (It is the rule most generally used, and will hold out in ordinary good corn, even if measured at the time it is cribbed.) The result will be the number of bushels of shelled corn.

Measure of Apples, Potatoes, Turnips, etc.

To find the number of bushels in a bin: —

Rule. — Multiply the length, breadth and thickness together, and this product by 8; point off one figure in the product for decimals, and the result will be very near the number of bushels.

Any small or irregular solid, as fruit or vegetables, may be estimated by placing the body in a vessel of convenient shape and pouring in a liquid until the solid is quite covered; then, noting the level, remove the solid and again note the level at which the liquid stands: the volume of the solid is equal to the volume of the vessel between the two levels.

How to Determine the Live Weight of Cattle.

Rule 1. — Measure, in inches, the girth round the breast, just behind the shoulder-blade, and the length of the back from the tail to the fore part of the shoulder-blade. Multiply the girth by the length, and divide by 144. If the girth is less than three feet, multiply the quotient by 11; if between three and five feet, multiply by 16; if between five and seven feet, multiply by 23; if between seven and nine feet, multiply by 31. If the animal is lean, deduct $\frac{1}{20}$ from the result.

Rule 2. — Take the girth and length in feet, multiply the square of the girth by the length, and multiply the product by 3.36. The result will be the answer in pounds. The live weight multiplied by .605 gives a near approximation to the net weight.

Timber Measure.

To find the volume of a squared or four-sided timber: —

Rule. — Multiply the mean breadth by the mean thickness and the product by the length, and take the result for the volume.

To find the volume of a round or unsquared timber: —

Rule. — Multiply the square of the mean quarter girt by the length, and take the product for the volume. Or, —

Multiply the square of one-fifth of the mean girt by twice the length.

The last rule gives a result which is very nearly exact when the piece of timber is exactly a circular cylinder.

To find the superficial contents of a board or plank: —

Rule. — Multiply the length by the breadth. When the board is broader at one end than at the other, add the breadth of the two ends together, and take half the sum for a mean breadth. Or, —

When the breadth of the board is in inches, or feet and inches: —

Rule. — Multiply the length of the board in feet by its breadth taken in inches and divide this product by 12, and the quotient is the contents in square feet.

Number of shingles required to cover a roof: —

Rule. — Multiply the number of square feet in the roof by the number of shingles per square foot, and the product will be the number of shingles required.

(To the square foot it takes 9 shingles if exposed 4 inches; 8 if exposed $4\frac{1}{2}$ inches; $7\frac{1}{2}$ if exposed 5 inches, to the weather; carpenters, however, usually reckon 1,000 shingles for every 100 square feet of surface when the shingles are exposed $4\frac{1}{2}$ inches.)

To find the contents of a wood pile: —

Rule. — Multiply the length, breadth and height together, and divide the product by 128, and the result will be the number of cords in the pile.

To find the cost of a load of wood: —

Rule. — Multiply the number of feet in the load by the price per cord, and divide the product by 128, and the quotient will be the price of the load.

Cistern and Cask Measure.

To find the capacity of a round cistern or tank: —

Rule. — Multiply the square of the average diameter by the depth, and take $\frac{3}{16}$ of the product. The result will be the number of barrels in the cistern. (For greater accuracy, multiply by .1865 instead of $\frac{3}{16}$.)

To find the capacity of a square cistern: —

Rule. — Multiply the cubic feet by $.2\frac{3}{8}$ (tenths).

To find the number of gallons in a cask: —

Rule. — Add into one sum 39 times the square of the bung diameter, 25 times the square of the head diameter and 26 times the product of these diameters; multiply the sum by the length of the cask, multiply the product by .000031473, and the result may be taken for the volume of the cask in gallons.

Drainage.

The Conditions of Drainage.

(*a*) Amount of water in the soil.

(*b*) Amount of rainfall.

(*c*) Degree of moisture in the air.
(*d*) The tenacity and power of soil to hold water.

Kinds of Drains used.

(*a*) Open ditch.
(*b*) Stone drains.
(*c*) Mole drains.
(*d*) Tile drains.

Tile drains are best, and when well laid will last at least fifty years. The tile should be porous, and laid below the frost line. Several forms of tiles are made; the cylindrical form is considered best. The usual size of these tiles are $1\frac{1}{4}$, $2\frac{1}{4}$, $3\frac{1}{2}$ inches in interior diameter.

The depth and width between drains depend largely upon the nature of the land. For good, thorough drainage of any kind of soil, the drains should be at least 3 feet deep and from 15 to 20 feet apart; often the dimensions are $3\frac{1}{2}$ feet to 4 feet deep and 40 feet apart; in sand and porous soils the distance may be increased to 50 feet. Drains in sand and gravel need not be as near together as those in a clayey soil. They should, as nearly as possible, run parallel to each other.

The drain should be placed in the line of greatest fall, and all small or lateral drains should be conducted into the larger or main drains.

The least rate of fall it is prudent to give to a drain in using ordinary tile is 2.5 feet in 1,000 or 3 inches in 100 feet, and even this requires very careful work. A fall of 6 inches in 100 feet is recommended when it can be easily obtained.

To a certain limit, the greater the fall the smaller the pipe may be.

Tar paper should be placed over the joints between the tiles.

In soft ground the tiles may be placed upon boards laid at the bottom of the drain.

Begin digging the drain and laying the tile at the point of outlet.

The following table will show the number of drain pipes required per acre at various intervals, and of different length of pipes, beginning with those of 12 inches in length, up to those of 15: —

Spaces between the Drains.	Twelve-inch Pipe.	Thirteen-inch Pipe.	Fourteen-inch Pipe.	Fifteen-inch Pipe.
15 feet, ...	2,904	2,680	2,489	2,323
18 feet, ...	2,420	2,234	2,074	1,936
21 feet, ...	2,074	1,915	1,778	1,659
24 feet, ...	1,815	1,676	1,555	1,452
27 feet, ...	1,613	1,489	1,383	1,290
30 feet, ...	1,452	1,340	1,244	1,161
33 feet, ...	1,320	1,219	1,131	1,056
36 feet, ...	1,210	1,117	1,037	968
39 feet, ...	1,117	1,031	957	893
42 feet, ...	1,037	958	888	829

The Results of Draining.

(*a*) Staple soil is made deeper.

(*b*) Soils are more easily and sooner worked.

(*c*) Lime and manure act better.

(*d*) Temperature of the soil is increased, resulting in more favorable conditions.

(*e*) Seed-time and harvest are earlier.

(*f*) Larger and better crops, and

(*g*) Good natural grasses spring up.

(*h*) Green cropping can be introduced, and

(*i*) Bare fallowing done away with.

(*j*) There are fewer noxious insects.

(*k*) The health of the live stock is improved.

Facts Concerning Frost.

Thousands of dollars are lost to farmers and gardeners annually from frost.

If the sky is cloudy or there is a brisk wind, there is little or no danger from frost.

A thin cloth, a layer of straw or even a cloud of smoke, will protect tender plants unless the frost is severe.

Take two thermometers just alike, cover the bulb of one with thin muslin, keep the latter constantly wet by having a wick

fastened to it and dipping in a cup of water; the dry bulb gives the temperature of the air, the wet bulb the evaporation temperature. With this instrument during the period of early and late frosts a person can determine with considerable accuracy if frost will occur the following night.

Gen. A. W. Greeley (formerly chief of the Weather Bureau at Washington) says: "A safe and simple rule to follow when the temperature is at 50° or below, is to multiply the difference between the readings of the wet and dry thermometers by 2.5, and when the sum thus obtained is subtracted from the reading of the dry thermometer it leaves the approximate degree at which the temperature of the air will fall the coming night, unless change of wind to a moist quarter or increase of cloudiness interferes."

The wet and dry bulb thermometers and clear sky and still air will give at least five or six hours' warning, and this is ample time to enable one to apply protective measures.

VETERINARY.

JAMES B. PAIGE.

Practical Suggestions in Relation to the Preservation of Health of the Domestic Animals.

Disinfection of Buildings.

As our knowledge of medicine increases, it seems probable that all of our contagious or infectious diseases are caused by a vegetable parasite or micro-organism, commonly called a germ. It has also been proved that many of our so-called sporadic diseases are produced by these low forms of life. The more these are studied, the more certain are we that they stand in close relation to the primary causes of diseases in both man and the domestic animals. Each by its entrance into the body and by its action or the action of its products upon the tissue produces its own peculiar effects, which are noticed in each particular disease. Many of the germs resist for a long time the action of a moderately high degree of heat, drying, moisture, oxygen and decomposition. Most of them are preserved by the production of spores which are more resistant than the germs. While nearly all have characters in common, each possesses one or more characteristics by which it may under

certain conditions be recognized. The germ diseases affecting an animal or person are spread by the entrance of the disease-producing bodies into a healthy body.

The most important and more common of the contagious diseases of the domestic animals which may in certain cases be transmitted only to members of the same species, in other cases to members of other species of animals and to members of the human family, are glanders, tuberculosis, anthrax, rabies, variola, pleuro-pneumonia, hog cholera, swine plague, strangles, influenza, canine distemper, chicken cholera; also other diseases, caused by animal parasites, — scabies, ring-worm, trichina, etc. Of the same class of diseases of the human family may be mentioned small-pox, scarlet-fever, diphtheria, measles, typhoid fever, Asiatic cholera, yellow-fever, tuberculosis, etc.

The means by which these diseases are spread vary according to the nature of the malady and the organism which produces it. In some it requires direct contact of the healthy with the diseased animal or its products; in others, cohabitation is sufficient. The germs may be carried from the sick to the healthy by food or water, by utensils, by the clothes or the body of the person attending the animal, or by the medium of the atmosphere.

The object of disinfection is the destruction of these disease-producing bodies when outside the animal body. By disinfection we endeavor to control and prevent the spread of disease from the affected to the healthy animal. Of the common and effective agents used for this purpose may be mentioned, heat, fumes of sulphur and chlorine, corrosive sublimate, carbolic acid, chloride of lime, and quick-lime in the form of whitewash. The use of the one or the other depends largely on the nature of the object to be treated. It may be necessary that only one be used, or it may be advantageous to employ two together.

Heat, as a disinfectant, if properly used, is the most reliable. Burning may be resorted to in case it is best to destroy the material. It is applicable to the destruction of litter, word-work or other things which may have become contaminated by a virulent and fatal virus, or the body of an animal dying of some of the contagious diseases. Germs in these materials resist for a long time such natural destructive agents as drying, moisture, freezing, burying, etc.

Destruction by fire is preferable to burying, for certain organisms generating disease find in soil favorable conditions for rapid multiplication and preservation. In such diseases as anthrax and pleuro-pneumonia the body is best disposed of by cremation. In like manner the wood-work and the litter about the stall of a horse

suffering from glanders should be burned. Iron or wood-work about a stable in many cases may be thoroughly disinfected by singeing with a flame from a torch. This method can only be employed where there can be no possible chance of setting fire to the building. It is particularly applicable to iron lattice work used between stalls, to iron mangers, brick walls or plaster.

Dry heat is a perfect disinfectant, providing the contaminated object be subjected for fifteen or thirty minutes to a temperature of 300° F. No germs can remain alive any length of time at this temperature. If the object to be treated is large and compact, it becomes necessary that it be exposed to this heat for a sufficient time, so that all parts be raised to this temperature. Glass, tin and iron ware, knives, clothing, brushes, etc., are best disinfected by this method, and ordinarily may be treated in a common stove oven. In case a thermometer cannot be used, a loose wad of cotton batting placed in the oven may be used to tell when the temperature has been raised sufficiently high, as it will, after a short exposure to a dry heat of 300° or 350° F., become slightly browned.

Moist heat in the form of boiling water or steam is particularly adapted to the disinfection of articles which will not withstand the high temperature of the oven, or which are ruined by dry heat. It is commonly used in the disinfection of clothing, etc. In many cases prolonged boiling or steaming is necessary for the heat to affect every part of the object being treated. Usually one-half hour of boiling is sufficient, but the work is more thorough if the articles are subjected to the action of the water or steam for fifteen or twenty minutes each day for three consecutive days. Compressed steam penetrates more rapidly and destroys germs more quickly than boiling water or steam which is allowed a free exit. The addition of a small quantity of carbolic acid, one part of the strong acid to one hundred parts of water, renders the steam more effective.

Sulphurous acid gas is one of the best aerial disinfectants known. It is especially valuable in the disinfection of stables, from the fact that it is easily used, safe about the buildings, and non-poisonous when taken into the stomach. It has little or no injurious effect upon the fodder with which it may come in contact. The method of preparation and use is as follows: All animals should be removed from the room to be fumigated, all doors, windows and ventilators closed. The gas may be safely generated by burning the flour of sulphur in an iron vessel, which may, as a precautionary measure of safety, be placed upon a brick in a tub containing a small amount of water. The sulphur may be ignited by a few live coals, or by pouring upon it a little alcohol, which is then

lighted. The vessel containing the burning sulphur should be moved from place to place in the stable. That the work may be thorough, at least three pounds of sulphur should be burned for each one thousand cubic feet of space to be disinfected. The fumes should be allowed to remain not less than twelve hours, but a period of twenty-four hours is better. If less sulphur than advised above is used, the work will not be satisfactory. Before the animals are replaced in the building it should be thoroughly ventilated.

Chlorine is a powerful disinfectant and deodorizer, and is strongly recommended by some. As compared with the fumes of sulphur, it is but little better as a germ destroyer. It has the disadvantage of being strongly corrosive. It cannot be used freely where fodder is or where other material is stored. For all practical purposes sulphur is sufficient, and the use of chlorine should be entrusted to the veterinarian.

Carbolic acid (one part to twenty of water) is largely used as a local disinfectant for the treatment of wood or iron about places occupied by diseased animals; it is invaluable in disinfecting mangers, stalls, partitions and floors. In dilute solution small quantities are harmless to the animal, even if taken directly into the stomach. Crude carbolic acid is also used in the disinfection of contaminated soil or manures, and in certain cases the offal and bodies of animals dying of contagious diseases. It is particularly valuable in ridding stables and hen-houses of lice and other parasites. One part of strong acid with twenty parts of raw linseed oil or castor oil may be employed in the destruction of those parasites which live upon the skin of the domestic animals, and which are the cause of many of the contagious skin diseases. For disinfecting buildings a solution of one part of the strong acid to twenty parts of water should be used. It is easily applied with a brush. It should be used liberally, and every part should be well covered. After it has been allowed to dry there is little danger to animals, though they may come in contact with the parts of the building treated. For use on soils or manure heaps or bodies, strong solutions may be used. The crude acid is suitable for all purposes of disinfection of buildings, but only the refined should be used for application to the animal. While there is little danger from the use of strong solutions of this drug upon the interior of buildings, it must be remembered that the undiluted drug in small or the dilute solutions in large quantities are active irritating poisons when taken into the body.

Corrosive sublimate is the most powerful disinfectant used, with the exception of fire. A weak solution of one part to five thou-

sand parts of water destroys the lower forms of life. It is extremely poisonous, and on this account its application is limited as a disinfectant. It may be used to advantage in connection with the disposal of the carcasses of animals dying of certain infectious diseases, provided they are to be buried beyond the reach of dogs and other animals. The walls, ceilings, floors, partitions, etc., of buildings which have been occupied by animals suffering from contagious disease may be rendered harmless by being carefully washed with a solution of one part of corrosive sublimate to one thousand parts of water, approximately sixty grains of the sublimate to one gallon of water. Some recommend that the sublimate solution be used with lime, in the form of a white wash with which all parts shall be thoroughly covered. The lime in such cases has a beneficial effect by its action upon the organic matter which may have adhered to the wood-work. Care should be taken in the use of this drug about mangers, watering troughs, pails, etc., as small quantities produce fatal results when taken into the body. As the use of carbolic acid solution is less liable to be attended with unfavorable results, it is better in most cases to employ it.

Chloride of lime possesses no advantages over carbolic acid, except that it is applied more easily, and to some extent purifies the air of the building. When scattered upon the floor it continues for some time to give off chlorine, which has a tendency to destroy the germs floating in the air. It may also be used on contaminated soils or refuse material. It cannot be relied upon alone to thoroughly disinfect all parts of a building, but is best used upon the floors in connection with an application of carbolic acid, corrosive sublimate or sulphurous acid gas to the walls and ceilings.

In the work of disinfection it is all-important that it be done thoroughly. Everything which has come in contact with the diseased animals, including clothing, cleaning utensils, pails, and even the hands of the person attending the sick, should be carefully treated. Too great care cannot be exercised in this connection. The success of getting rid of contagious matter from a building depends wholly upon the thoroughness of disinfection, provided the source of the contagion has been removed.

Sanitary Stable Construction.

While all sorts of buildings are used as stables for animals, it is a well-proved fact that those which are improperly constructed, so that they cannot be kept clean, ventilated or lighted, are the breeding places of disease. Tuberculosis among cattle, glanders and influenza among horses, spread with great rapidity and are more fatal when appearing among stock kept in such buildings.

In selecting a location for a stable, procure, if possible, one having some natural protection from bleak and cold winds. Build upon a dry, gravelly soil, if circumstances permit. Damp, clayey soils are unhealthful, from the fact that they retain for a long time large quantities of organic matter, which by decaying slowly continue to give off impurities. Again, where the soil under the stable is filled with standing water, the air of the building becomes very damp, a condition unfavorable to the health of any domestic animal, especially the horse. If it becomes necessary to build upon damp soil, it should be first thoroughly underdrained.

The position of one building in relation to another is a matter that should not pass unnoticed. So locate a stable that the air coming into it shall not be contaminated from the adjoining building, the barn-yard or the manure pile. Do not place one building so as to exclude the air or light from another.

When constructing a stable, always keep in mind the importance of ventilation; make some provision for it by providing a sufficient number of inlets and outlets for the introduction of pure air and the escape of impure. Place them in relation to each other so that draughts shall not be produced that will strike upon the bodies of the animals.

Never build without making ample provision for lighting. Horses kept in dark stables suffer from diseases of the eyes. It is preferable to have the light enter at the rear of the stall; a bright, glaring light shining directly through a glass into the eyes greatly annoys animals that have no means of protecting these sensitive organs. The use of ground or colored glass under such circumstances is recommended.

Stables should be properly drained, in order that the urine may not remain in them to decompose and give off impurities into the atmosphere. Open-surface drains are better than pipes, in that they are more easily inspected and cleaned. The use of traps in the building is to be avoided whenever possible. If a stable drain is connected with a sewer, the connection should be made outside of the building, and at this place a ventilated trap may be placed. A cast-iron surface drain, with a rough, perforated movable covering, is best for use inside.

The requirements of a good stable floor are that it shall be hard, durable, not slippery when wet or dry, non-absorbent, easily cleaned. Tile prepared for the purpose answers these requirements best. Asphalt and cement are very good, but are not as durable; they have the advantage of being less expensive. The great objection to wood, especially for horses, is that it becomes quickly worn, particularly when the shoes are calked; again, after

short use it becomes filled with large quantities of urine and particles of the solid excrement. When stall floors are laid, they should be given a slope of about two inches from front to rear, just enough to carry off the urine into the drain behind. More slant to the floors on which horses stand has an injurious effect, by causing strain of the flexor tendons, or navicular disease by the continued pressure of the tendons upon the navicular bone.

Stall partitions for horses should afford perfect separation of the animals, should be strong, and still not exclude light nor interfere with the free circulation of the air. Those built about three and one-half feet high, of two-inch plank, placed vertically or horizontally, securely fastened at the head and foot, having at the front part above a cast-iron or strong wire lattice work, fill the requirements.

The position of the hay rack in relation to the manger is a point of importance in horse stalls. Frequently the rack is placed directly over the manger, in other cases a large box-like manger extending across the front of the stall serves for both hay and grain; both are objectionable, as the dust and dirt from the hay falls and remains in the bottom of the manger, so that when the grain is put in they become mixed, and the horse in order to get the grain is obliged to eat more or less foreign matter; this has an injurious effect upon the teeth, causing excessive wearing and frequently breaking or splitting of these organs. Iron racks and mangers are the most sanitary and durable; they are easily kept clean and sweet in hot weather, and moisture is not absorbed by the iron as by wood. To prevent the dust and dirt from the hay getting into the manger, it should be placed in one corner of the stall, the hay rack in the other.

Ventilation of Stables.

While much has already appeared in veterinary works and agricultural papers upon this important subject, examination of the stables of many of the most progressive farmers and stock raisers shows that it does not receive the attention that its importance demands.

While all recognize the value of fresh air for the proper performance of the functions of the respiratory organs and the blood, and the consequent healthfulness of the animal, it is not provided for stock, from the fact that owners apprehend that there is a loss of nourishment in food supplied to animals kept in cool stables, and a danger to them when subjected to the influence of a draught of fresh air. While there may be a slight loss of the food constituents which are used to maintain body heat, and a danger from

currents of fresh air, they are not of sufficient importance to offset the greater dangers consequent upon keeping stock in a close stable, surrounded by an atmosphere filled with the products of respiration and organic impurities given off from the body or arising from the decomposition of animal excrement.

As a return for food furnished the animal, we should look for something more than so much muscular force, vital energy, meat or milk We ought at all times to bear in mind that the most healthful animal can give us in return for the expenditures made upon it these things in the greatest abundance, — health first, product second. It is poor economy to so keep our stock that a little more of their products may be given to us, while the health of the animal is made to suffer by so doing.

Without supplying fresh air for the proper aeration of the blood, it is impossible by any system of feeding to preserve the health of domestic animals. This becomes apparent when we consider that every cell of every organ of the body is dependent for the proper performance of its functions upon a supply of pure blood. The blood, in turn, for the best performance of its functions is dependent upon an unlimited supply of pure air. Interfere with the aeration of the blood, and you at once interfere with the process of digestion and assimilation of food, the secretion of milk, the production of fat, — in fact, all the vital forces of the body are weakened.

The objects of ventilation, briefly stated, are: the supply of fresh air to the lungs, the dilution and removal from the stable of the products of respiration and exhalation from the body, and the products derived from the decomposition of the animal excreta. The impurities derived from these sources consist of carbon dioxide, organic matter, ammonia and other gases in small quantities. The greater part of the carbon dioxide is given off from the body through the lungs with expired air. While it is a deadly poison when inhaled undiluted in large quantities, in such amounts as are ordinarily found in the air of stables it does directly but little harm. It is, however, one of the most important constituents of impure air, as by a determination of the quantity present we can calculate how much organic matter is present, how much fresh air is necessary for each animal, and we can also tell how much fresh air has to be supplied to each animal per hour. The organic matter comes as a product of respiration and excretion from the body and from decomposing excreta from the animals. It is by far the most dangerous constituent of stable air.

The quantity present is in proportion to the amount of carbon dioxide given off through the lungs, which in the average-sized

horse and cow amounts to about 6.5 cubic feet per hour. Dividing this amount by the greatest amount of carbon dioxide which may exist in stable air and still have it fit for respiratory purposes, will give the amount of fresh air required per hour and needed to keep the air of the stable sweet and pure, suitable for respiratory purposes. It has been found, as a result of numerous experiments, that .2 of carbon dioxide per 1,000 volumes of air, in addition to that existing in practically pure air, which is left out of the calculation, represents the maximum of organic matter that may be present in the air of the stables, and still have it in condition for the lungs. If we make the calculation, we find that 32,500 cubic feet of fresh air are required for each full-sized animal. By determining how much carbon dioxide there is in the air exactly by chemical tests, or approximately by the sense of smell, and by dividing the amount given off from the lungs each hour (namely, 6.5 cubic feet) by the amount of carbon dioxide found in the stable, we can estimate the quantity of fresh air which has been supplied to each animal per hour.

The other impurities, consisting of ammonia and other gases in small quantities, are derived from the decomposition of the excrement, urine in particular giving a large quantity of ammonia. These constituents are not very injurious to the general health of animals, unless present in large amounts. Horses confined in close stables, when the air is filled with ammonia, are, however, subject to diseases of the eye and the respiratory organs, from the irritating effects of the gas upon the sensitive and vascular mucous membrane. The injurious effects of all other natural impurities of stable air are insignificant, compared with those of organic matter.

These impurities and their effects are to be disposed of by the process of ventilation, which consists of introducing pure air to take the place of the impure which is removed. The forces by which these may be accomplished are natural physical forces, consisting of the law of diffusion of gases, the difference in weight of bodies of air of unequal temperatures and winds. By the law of diffusion of gases, those of different densities become thoroughly mixed. As applied to ventilation of buildings, it prevents the carbon dioxide, which is much heavier than air, from settling upon the floor of the building The second force produces currents of air in buildings by the rising of the heated air, while the cold air, which is of greater density and weight, descends. This force is the basis of systems of artificial ventilation in which artificial heat is used. In such cases currents are produced and consequent changing of the air takes place. In the ventilation of stables this

force acts to some extent, the heat being derived from the bodies of the animals kept in it. The most important force, however, in the natural ventilation of buildings, is the wind, and in most instances is quite sufficient, provided buildings are so constructed that it may act to the best advantage.

Practically we want certain openings in the walls, which may act as inlets through which fresh air may enter, with other openings or outlets of the same size in the opposite walls, or through the roofs, by which the foul air may escape. These ought to be so arranged as to produce a perfect distribution of the fresh air coming in, and prevent a current striking directly upon the animals. These inlets and outlets may be shafts or tubes, with or without cowls; free or shuttered openings or ordinary windows placed in the walls on each side of the building, hinged at the bottom so as to swing in at the top. Those on the windward side may be used as inlets, those on the leeward as outlets. In case the direction of the wind changes, then their action is reversed. When those on one side are open to admit fresh air, those on the opposite side should be open equally wide to allow the escape of the impure air. By being hinged at the bottom and swinging in at the top, the current of incoming air when it strikes the partially opened window is directed upwards. This insures thorough distribution of cool, fresh air in the upper part of the stable, before it settles into the lower part of the room and comes in contact with the animals. It also prevents draughts of air directly against the bodies of the creatures. As another aid to the distribution of the air and the prevention of draughts, it is oftentimes advisable to place in front of the inlet, at some distance from the opening, some obstruction in the form of a shutter or a break made of burlap, so placed as to direct and distribute the incoming current of air.

The aim should be in the ventilation of buildings to supply a liberal quantity of fresh air for each animal in the stable, and to distribute it thoroughly and evenly, without draughts. The direction of the movement of air may be determined by the use of smoke generated by burning a wisp of damp straw or by exploding a little gunpowder upon a paper, or by the movement of such light objects about the building as cobwebs, dust or lint.

The size of the opening used as an inlet for admitting a sufficient quantity of fresh air for a horse or cow depends upon the velocity of the wind. Knowing the quantity required by an animal per hour, and the velocity of the wind, we can by the following table calculate approximately the size of an inlet necessary to admit that quantity of air per hour: —

DESCRIPTION OF WIND.	Mean Velocity in Miles per Hour.	Size of Inlet to admit 32,500 Cubic Feet of Air per Hour.
Calm, ...	3	2 05 square feet.
Light air, ...	8	.77 square feet.
Light breeze, ...	13	.473 square feet.
Moderate breeze, ...	23	.26 square feet.
Fresh breeze, ...	28	.22 square feet.

The figures in the right-hand column refer to the size in square feet of an opening necessary to admit 32,500 cubic feet of air per hour, the quantity required for a full-grown horse or cow.

If we know the size of the ventilators or windows, their number and the number of animals, we can tell at a given velocity of the wind how wide the ventilators or windows must be open to admit the requisite quantity of air. The rule is to multiply the number of animals to be supplied by the figures in the right-hand column; divide this by the number of windows or openings on the windward side of the building, and you have the size, in square feet, to which each should be opened. To reduce to linear inches, multiply the last number obtained by 144, and divide that by the width of each window in inches. This will give the number of linear inches to which each window or ventilator should be opened to admit 32,500 cubic feet of air for each animal, with the wind moving at a given velocity. Making the calculation according to the table, for one horse, with a window 30 inches in width, it would need to be opened in the first case, with the wind moving at the rate of three miles per hour, about 10 inches; with the wind at eight miles per hour, $3\frac{3}{4}$ inches; at 13 miles, $2\frac{1}{4}$ inches; at 23 miles, $1\frac{1}{4}$ inches; at 28 miles, about one inch.

We must bear in mind that there must be on the leeward side or through the roof of the building outlets for impure air of the same size of the inlets. By this means we can only calculate approximately; by determining exactly the velocity of the wind by an anemometer, we could tell precisely the size of the opening with a given velocity of wind; but as these are not always accessible, we may use the table given, judging of the velocity.

The Relation of Cubic Capacity to Ventilation.

Many who believe in the value of ventilation of buildings occupied by stock, but are fearful of bad results from admitting fresh

air, think that ventilation may be supplanted by building stables of large capacity. They imagine that, if an animal is provided with a large amount of cubic space, it does not require fresh air. Such is not the case. While a large amount of space is desirable, it cannot take the place of ventilation. If an animal requires 32,500 cubic feet of fresh air every hour, it requires but a short time to fill the atmosphere of a large stable occupied by animals with impurities. The air in a large stable becomes just as foul as that of a small one, — it only requires a longer time. While cubic capacity cannot take the place of ventilation, it is desirable, from the fact that the air of a large stable, if properly ventilated, requires to be changed a less number of times per hour than that of a small one. Frequent changes of the atmosphere mean a cool stable and draughts.

The amount of cubic space to be allowed each full-sized animal can be calculated if we determine the number of times per hour that an animal can bear to have the air of the building completely changed. If we say twelve times per hour, once in five minutes, then each would require 2,708 cubic feet of space ($32,500 \div 12$), a stall fourteen by fourteen by fourteen feet, or a smaller stall with the balance of the room in the body of the building. To keep our stables in cold weather warm and comfortable, and still keep them properly ventilated without the use of heating apparatus, is very difficult if not impossible; but a study of the occurrence of disease in animals leads one to conclude that a supply of fresh air is a more important factor in preserving the health of animals than is cold air in producing disease.

[Note. — For further study of this subject, the reader is referred to Smith's "Veterinary Hygiene."]

Feeding and Watering.

Feeding. — From a study of the anatomy and functions of the digestive organs of the horse, we conclude that he should be fed often, at least three times a day. The stomach in comparison to the size of the animal is quite small, and the digestion of the food in it very rapid; it can hold but a small quantity of food, and when in a state of health for a short time only.

Horses should be fed concentrated food, particularly so if compelled to work most of the time during the day, having only a short time for eating. Hay alone cannot be digested in sufficient quantities to supply nutrient material enough for the repair of the tissue, provided the creature is made to perform much labor. A liberal quantity of concentrated foods, together with sufficient coarse material to give bulk, is more essential for the horse doing road

work than for one engaged in slow work. Coarse food in large amounts overloads the stomach, which presses upon the diaphragm, interfering with free and easy respiration. When the animal is heated, avoid feeding grain. Give a small quantity of hay until the circulation of the blood has become equalized. When warm and sweating, large quantities of blood are in the vessels of the superficial parts of the body and but little in the vessels of the stomach. The process of digestion cannot take place unless blood is present; consequently, when a horse is warm and large quantities of food are introduced into the stomach, it remains there undigested, and soon undergoes fermentation, which is accompanied by the formation of gas; this collects in the stomach and intestines, distending them and producing flatulent colic.

After a long fast an animal should only be allowed food in small quantities until hunger has become somewhat appeased. The stomach weakened by fasting cannot digest large quantities.

The amount of grain should be lessened when animals are not doing their usual amount of work. This is of special importance to horses accustomed to working the greater part of the day. If allowed to remain idle no longer than one or two days, the oats or corn should be reduced, and in most cases it is advisable to substitute in part coarse wheat bran.

Sudden changes of food are liable to be followed by an attack of colic, particularly if the change from oats to corn or hay to grass is made. To avoid bad results, gradually accustom the horse to the change.

Food for horses should be of the best quality. Inferior and damaged material of any sort, musty, mouldy hay, oats or corn, produce in horses intestinal disturbances, and frequently disease of the urinary organs.

Watering. — A horse should be given a small quantity of water at frequent intervals. Large amounts of cold water chill the intestines. When at work, and even when heated, small quantities may be allowed; large draughts at such times are apt to produce colic. Either water one-half hour before feeding or one hour after. If cold water is given just before feeding, the blood vessels of the stomach and intestines become contracted, and the blood is forced out of them. If food is eaten at once, it may remain undigested in the stomach. If watered soon after feeding, undigested food is washed out of the stomach into the intestines by the passage of the water through the stomach into the cæcum. The stomach and small intestines retain but little, most of it passing through into the large intestines.

Hints on Management of the Feet, and Shoeing.

Keep the feet of the horse clean; neglect of this precaution is followed by the development of thrush, and lameness. Manure and urine remaining in the feet for considerable length of time cause thrush. Hard objects, such as stones, which become lodged in the feet and allowed to remain, pressing upon the soles, are a frequent cause of bruising and lameness.

Do not allow the foot to grow too long at the toe. Increased length at this point increases leverage, and consequently strain upon the tendons and ligaments in the foot and leg, resulting in the growth of spavins and ring-bones, etc.

Colts, when kept in box stalls or soft pastures, where their feet are not worn away sufficiently, should receive particular attention. Keep the lower portions of the feet level, so that each part shall support its share of the weight of the body.

Avoid shoeing young animals as long as possible. Contact of the foot with the ground is a natural condition, and it tends to keep the parts in a healthful state. Shoes are unnecessary until the horn becomes worn away so much that it does not afford protection to the soft, sensitive tissues within.

The first and prime object of shoeing is the protection and preservation of the foot. When the wear of the horn becomes greater than the growth, then it becomes necessary to apply some defence, if the horse is kept at work. The simpler the defence, and the less the foot is mutilated in attaching it, the better.

One of the most important points in shoeing is to keep the foot and shoe perfectly level, so as to give to each part an equal bearing upon the ground.

In preparing the foot for the shoe, avoid cutting or rasping any part except that upon which the shoe rests. The amount to be cut from the heel and toe must be determined by the natural shape of the foot. Partially detached flakes of horn are all that should be removed from the sole. The bars should be allowed to remain intact, unless they are so prominent as to interfere with the setting of the shoe.

The knife need never be used upon the frog when it is in a healthy condition. There is, however, no objection to removing partially detached portions.

In selecting shoes for an animal, be guided by its size and the work required of it. On general principles, they should be as light as possible and still retain their shape. If the soles of the foot require protection, they should be of good width, otherwise narrow ones are sufficient. Both upper and under surfaces should

be perfectly level. The border should correspond in shape to the margin of the lower part of the wall upon which it rests. All parts of the foot should have an equal bearing upon the shoe. For this reason the shoe at dull red heat may be applied for a short time to the foot. In attaching, use as few and small nails as will hold them in place. They should be driven low, especially near the quarters. Clinches should be small; large ones hold the shoe in place no better than small ones. If a shoe is accidentally torn from the foot, small clinches do less harm than large ones. Any roughness of the nails or the lower part of the wall may be removed with the rasp, but under no consideration should other parts of the wall be rasped. Shoes should be removed whenever they become loosened, or when any part of the hoof has overgrown them so that they press upon the sole.

CHEMICAL.

CHARLES WELLINGTON.

Notes on Nitrogen Manuring.

The three elements of plant food, nitrogen, phosphorus and potassium, rank in this order in price, nitrogen being the most expensive. A recent calculation has shown the following data as to the amount of these elements in nature. The figures in each case represent the number of pounds in every one hundred pounds of the earth's crust, water and air taken together: —

Potassium, ...	2.23 per cent.
Phosphorus, ...	0.09 " "
Nitrogen, ...	0.02 " "

A cause for the relatively high price of nitrogen might be traced in these figures. This is much more plainly shown by a study of each of the three elements, its behavior in free and combined condition, and its relations to air, soil and plant.

Potassium and phosphorus have strong affinities for other elements. They are not found naturally in the free state, but in combination, usually with oxygen. The compounds are known as potassium oxide and phosphoric acid. They are solid substances,

and in nature are always still farther united in more complex materials. In these combinations they are more or less soluble, but generally not to such an extent as to be easily washed away by drainage, hence they are retained in the soil.

Nitrogen differs radically from the other two elements, in its tendency to remain isolated. It is exceptionally devoid of affinity for other substances, and must be brought into combination by indirect means. Unlike them, it is a gas, and as such, makes up four-fifths of the atmosphere. Its compounds are distinguished by their tendency to decompose. The instability of substances known as explosives, nitrates, etc., of albumen and other similar bodies, is due to this inherent tendency of nitrogen to become free.

So-called nitrogenous matter is almost constantly undergoing change, especially when in the soil. The products of these changes are nitrogen itself, ammonia and ammonia compounds, and salts, called nitrites and nitrates. These are all very soluble, and easily lost in drainage waters; especially is this true of nitrites and nitrates. The nitrogen and ammonia, being gases, readily escape into the air.

It is clear, then, that, while potassium and phosphorus, or, in other words, potassium oxide and phosphoric acid, are lost only to a slight extent by drainage and not at all by evaporation, the stock of nitrogen on a farm is at all times liable to serious loss by both processes. For this reason, and the further one that the efficiency of each of these elements depends upon a proper supply of each of the others, it is apparent that no more important question is presented to the farmer than that of the economical management of nitrogen.

Much time and effort expended on the study of this subject has yielded, especially during the past few years, a large amount of practical information. The purpose of these notes is to state briefly some of the results of such study, chiefly as they have been presented by Hellriegel and Wagner.

Nature offers the crop free nitrogen and combined nitrogen. Until recently no process had been discovered by which the former was known to become available as food for plants. The theory and practice of nitrogen manuring had, therefore, been confined to the application of various compounds of this element. These are nitrates, ammoniates, and many constituents of plant and animal bodies and excrements.

It is now established that all leguminous plants, such as pease and alfalfa, have the power to draw free nitrogen from the atmosphere. Experiments thus far show that no others are able to do this. The difference between plants of these two divisions, in

this respect, is indicated by a comparison of the life-history, for example, of barley and pease.

A barley-corn and a pea-seed germinate, and the young plants live on material stored in the seed. When this is exhausted, food is sought in the earth and air. From the air, however, only carbonic acid is obtained. All the rest now comes from the soil. If the soil contains assimilable nitrogen, each plant draws from this till the end of its growth, and in the development of the two there is no difference. If, however, assimilable nitrogen is not present, or only in insufficient amount in the soil, a very remarkable difference in the growth of the two plants is to be noticed. In such case, the barley, starving for nitrogen, passes through its prescribed stages of development to seed ripening. As the young plant lived on the seed, so now it lives on its older organs, leaves and roots, and from these draws material for formation of roots, leaves, stem, flowers and fruit; but no increase in organic substance can be made. The mature plant contains whatever nitrogen has been drawn from the seed and the soil. If the latter yielded none, then the harvest actually contains somewhat less than that in the seed planted. The barley plant has no other source of nitrogen than that of the seed planted and the soil.

The pea plant, however, at this stage, also starving for nitrogen, has the capacity to enter into a life partnership with a certain microscopic organism. This partnership is characterized by the appearance of tubercles on the roots of the pea plant, and by a fundamental connection between the formation of these tubercles and the *assimilation, as plant food, of the free nitrogen of the air by the plant.* The plant itself has no power to assimilate free nitrogen. This comes solely from the co-operation of microscopic organisms of a definite kind in the soil. If these are not present, the pea plant matures under precisely the same circumstances and in the same manner as the barley plant.

The legumes do not take up nitrogen from the atmosphere as readily as from the soil, and do not draw from it until the supply from the soil is exhausted. But experiments prove that it is generally unprofitable to apply nitrogenous fertilizers to these plants, because they can be forced to draw from the atmosphere.

In reckoning the amount of nitrogen to apply to the non-leguminous crops, attention must first be given to the amount of this element which the different crops remove from a given surface, as one acre. For instance, in round numbers: —

Barley removes 53 pounds per acre.
Oats remove 62 pounds per acre.
Potatoes remove 89 pounds per acre.

It would not be good management, however, to apply these amounts, or relatively these, in manuring the three crops, because from *unmanured* soil they will remove nitrogen in the following proportions: —

Barley,	100
Oats,	108
Potatoes,	258

This is not because the oats and potatoes possess a greater power to acquire nitrogen from the insoluble substances of the soil, but because of their longer period of growth.

As we have mentioned before, the nitrogenous material of the soil is constantly changing, with a general result of the gradual formation of soluble substances, as ammonia and nitrates.

A plant having a long period of growth in which to take up the nitrogen, as it slowly becomes soluble, has a great advantage over the one with only a short period, and consequently requires a smaller application of nitrogenous manure. Potatoes have from three to four months in which to do this work; barley, only one-half this time, or even less; oats, a somewhat longer period than the barley. These periods correspond to the relative weights of nitrogen taken up by the different plants.

Plants having a short growing period, as mustard and rape, have greater need of quickly available nitrogen, in such form as Chili saltpetre, ammoniates, and easily decomposed organic substances. Those with a long growing period, as potatoes, beets, carrots and meadow grasses, have less need of nitrogen in these forms, for they have time to wait for the decomposition of substances like humus, barn-yard manure, bone meal, etc.

With an application of one hundred pounds of Chili saltpetre, it is reckoned that in round numbers the following yields may be produced: —

300 pounds of wheat, grain,
300 pounds of rye, grain,
400 pounds of barley, grain,
400 pounds of oats, grain,
180 pounds of rape, seed,
3,600 pounds of potatoes, tubers,
6,400 pounds of sugar beet, roots,
5,500 pounds of fodder beet, roots,
5,300 pounds of carrot, roots,

with the corresponding weights of straw and leaves in each case.

The actual yields which have been obtained in practice are sometimes above, sometimes below, those here indicated. A smaller

yield must be due either to the removal of the Chili saltpetre by rains beyond the reach of the plant, or to an excessive assimilation of nitrogen by the crop. In the latter case, analysis would show an abnormally high percentage of this element in the grain and straw.

Applications of ammonia sulphate generally yield, under like circumstances, smaller harvests than those of Chili saltpetre. On the average they are about nine-tenths as large.

Lime should be present in the soil whenever ammonia sulphate is applied, otherwise very poor results are obtained.

The nitrogen of organic materials varies in its value as a manure. This is greatest in meat, blood and finely ground fish, and least in hair, horn shavings, and coarse fish scraps.

As the atmospheric nitrogen is assimilated by the leguminous plants, it is easily brought into the soil by ploughing under a crop of pease, beans, vetches, etc., or by leaving the stubble of such a crop in the soil. On light soils, various non-leguminous plants, such as mustard and buckwheat, are often grown in the fall and ploughed under. By such procedure the soluble nitrogen of the soil enters less soluble combinations in the crop, and is thus retained till the next season. The real value of this practice is not fully established. On heavy soils it has frequently yielded smaller returns, and is not to be recommended.

HORTICULTURAL.

SAMUEL T. MAYNARD.

Fungicides. — The use of copper sulphate in various forms has become a necessity in combating fungous diseases attacking all garden and farm crops.

Bordeaux mixture, formula: Six pounds copper sulphate (blue vitriol) dissolved in about three gallons of water, and four pounds caustic lime slacked in water enough to make a thin lime wash. When cool, mix together thoroughly, and make twenty-five gallons by adding water. This has also been entirely satisfactory when water enough has been added to make fifty or even seventy-five gallons of the liquid.

Ammoniacal carbonate of copper, formula: Proportion, six parts ammonium carbonate to one part copper carbonate; mix

together, and keep in sealed cans. Dissolve one pound of this mixture in twenty-five or fifty gallons of water, the last proportion being most commonly used.

Paris green has proved the most efficient insecticide for general farm, garden and fruit crops. Proportion, one pound to two hundred gallons of water. Used with the Bordeaux mixture, Paris green can be applied in larger quantities without injury than when used alone, and the lime causes it to adhere longer to the foliage.

The knapsack pump for the garden and the barrel pump for the orchard and field are absolute necessities for successful agriculture and horticulture.

The nozzles giving the best results in using fungicides and insecticides are those that produce a very fine spray or mist. A half-inch brass or iron pipe or a prepared bamboo extension rod must be used to reach the highest fruit trees. The "Vermorel" nozzles and those made on the same principle are the best.

The potato beetle and the potato blight and rot fungus are both destroyed by the use of the Bordeaux mixture with Paris green, at the rate of one pound to one hundred or two hundred gallons of the mixture.

Potatoes that have begun to rot in the field should be dug, well dried, and dusted with caustic lime slaked to a dust with a solution of copper sulphate, one pound to twenty-five gallons of water, and put in a cool place.

The carnation rust can be checked and probably prevented by a dilute solution of the Bordeaux mixture. If this mixture disfigures the blossoms, use the ammoniacal carbonate solution.

The "poplar rust," so often attacking species of the poplar, was so abundant during the fall of 1891 as to seriously injure the trees. This season, trees treated with the Bordeaux mixture retained their leaves longer and were entirely free from rusts, while those untreated were again seriously injured.

Soluble fertilizers, like nitrate of soda and the potash salts, should not be applied until the plants start into growth.

To secure the best results on permanently planted crops, like the large and small fruits, stable manure, ground bone and the other less soluble fertilizers should be applied in the fall or winter or very early in the spring.

In pruning fruit or ornamental trees, never cut away large branches if it can be avoided.

Paint any wound made in pruning with linseed oil paint, gas tar or shellac.

Never cut out *all* the suckers coming on old apple trees, but *thin them out*, leaving the best. These growths are an effort of the

tree to repair the injury from insects, exposure to sun or the bending of the branches by a heavy weight of fruit, etc.

The best time to remove dead branches is in the summer; for general pruning, during the winter and before the sap starts in the spring. In cutting off large branches, always cut on the under side first, so that the bark may not be torn off when the branch falls.

Evaporated sulphur is a certain remedy for nearly all kinds of mildews and blights under glass, and for the red spider. It also keeps the green fly and the mealy bug in check.

An abundance of sunlight, a low temperature and a dry house, are necessary for the successful growth of lettuce under glass.

In houses where fungous diseases are prevalent, spraying the foliage should only be done in the morning of bright, sunny days.

Fruits.

The Apple. — Few crops pay a larger per cent on the labor and capital invested than the apple. Good fruit cannot be grown without an abundant supply of plant food in the soil. An acre often yields two hundred dollars' worth of fruit, yet it is seldom that one-tenth of its value is returned to the soil in fertilizing elements. Fifteen hundred pounds of fine-ground bone and three hundred pounds of muriate of potash, or one ton of unleached hard wood ashes, with the same quantity of bone, make a good fertilizer for an acre of apple trees.

Spray the trees before the leaves unfold with copper sulphate (blue vitriol), one pound dissolved in twenty-five gallons of water. Then, after the leaves have unfolded, use the Bordeaux mixture until July 15, then the ammoniacal carbonate for the apple scab. For the codling moth, the tent caterpillar and the canker worm, add Paris green to the Bordeaux mixture, one pound to two hundred gallons.

Only such fruit as is carefully picked, sorted and packed will bring fancy prices.

The best varieties for general home use and the market in this locality are Red Astrachan, Gravenstein, Haas, Hubbardston, Rhode Island Greening, Baldwin and Roxbury Russet.

The Pear. — The pear comes into bearing younger than the apple, and is generally more profitable; although, as it is not shipped abroad, but is dependent upon local consumption, it is sometimes sold at very low prices.

To secure the best results, a rich soil and close attention to thinning the fruit are required.

The leaf blight and the cracking of the fruit, caused by the same

fungus, are almost if not wholly controlled by the copper solutions, used as for the apple.

The so-called fire blight is caused by the rapid growth, during extreme hot, moist weather, of a minute bacterial plant. No certain remedy is known, but trees making a moderately rapid growth and not allowed to overbear are less subject to its attack than those in a rich, moist soil, growing rapidly with the fruit not thinned.

The quality of all varieties is much improved if the fruit is picked from one to three weeks before it would naturally ripen on the trees.

The best varieties for market and home use are Giffard, Clapp, Bartlett, Sheldon, Bosc, Anjou, Lawrence and Dana's Hovey.

The Peach. — This fruit can only be successfully grown on elevated land with a western exposure.

Young trees should not be forced into a too rapid growth. The best fertilizer is fine-ground bone and muriate of potash or wood ashes. If the land is to be cultivated, corn is one of the best crops to grow among the trees for the first three or four years. When the trees have set a large crop of fruit, it is safe to apply manure or fertilizers very liberally, to enable the tree to mature it without injury.

When a full crop has been set, thinning must be done, leaving at least *four inches between any two specimens.* One hundred peaches from trees which have been thinned will often measure more than three times that number from unthinned trees, and will bring two or three times the price.

Peach trees can easily be kept in good condition for about fifteen years, with good treatment, but will not last much longer.

The only practical method of protecting the peach buds from winter-killing is to loosen the roots on the south side and bend the top to the ground, covering it with mats, straw or coarse litter of any kind. To prevent injury by mice, spray the trees before bending over with Bordeaux mixture and Paris green.

No distinct fungous or bacterial growth has thus far been found which causes the disease known as the *yellows.* Heading back the trees one-fourth of the new growth each fall or winter, using fertilizers containing all the elements of plant food — especially potash — in liberal quantities, and thinning the fruit when the trees are overloaded, will generally prevent this disease in New England.

The peach borer is best destroyed by the knife.

Best varieties for New England are Amsden, Mountain Rose, Old Mixon, Crawford's Early, Crawford's Late, Crosby (Excelsior) and Stump.

The fruit rot can be largely prevented by frequent applications of *very dilute* Bordeaux mixture (dilute to one hundred gallons of the mixture) about the time the fruit is ripening.

The Plum. — If planted a good distance apart, in a rich, well-drained soil, with a free circulation of air around and among them, plum trees can be successfully grown.

The black wart or knot, so destructive to the plum and sour cherry trees throughout the country, can be prevented by cutting off, by painting with kerosene paste and by spraying with the Bordeaux mixture. If the trees are badly infected, they should be severely headed back and a new head formed, upon which — with the above treatment — few if any warts will grow.

The plum curculio, the fruit rot and the blight or shot-hole fungus are largely prevented by the use of the Bordeaux mixture and Paris green.

Best varieties, Lombard, Bradshaw, Imperial Gage and McLaughlin.

The Grape. — On the higher hills in almost all sections of Massachusetts frosts do little injury until the first or middle of October, and on many of these hills grapes can be as successfully and cheaply grown as in the noted lake shore regions of New York and Ohio.

Native-grown grapes put on the market in a fresh condition, with the bloom uninjured, sell for from three to five cents per pound more than those coming from the West.

The powdery mildew and the black rot of the grape are not so injurious in New England as in the more western sections, but they seem to be increasing. They are controlled by the Bordeaux mixture and the ammoniacal copper carbonate.

Prune the vines any time when convenient, from the time the leaves fall until March 1, never later if it can be avoided.

Girdling the vines about July 1 hastens the ripening of the grape and increases the size of the berries. Observations of vines thus treated for ten years and even longer have shown their vigor to be generally unimpaired. By the use of the Bordeaux mixture, and girdling, some valuable late varieties and those much subject to the attack of the mildew or rot can now be successfully grown.

Best varieties for general purposes, Concord, Worden, Moore's Early and Winchel (Green Mountain).

Blackberries. — Plant on rather light land, and mulch if the season is dry. To prevent the winter-killing, the canes must be bent over and partly covered with soil.

To destroy the rust, spray before the leaves unfold with the copper sulphate, one pound to twenty-five gallons of water, and with the Bordeaux mixture after unfolding.

The best varieties are Agawam, Snyder and Taylor's Prolific.

Raspberries. — The red raspberry requires the same treatment as the blackberry, but should be planted on richer ground.

Varieties of red raspberries most successful in field culture are Hansel, Marlborough, Cuthbert; black caps, Souhegan, Gregg, Crawford and Nemeha.

The Bordeaux mixture and copper sulphate applied as described for the blackberry will control the anthracnose on the black caps.

Strawberries. — A deep, rich, well-drained loam gives the largest crop.

Spray with the Bordeaux mixture and Paris green as soon as the plants start into growth in the spring, for the spotted paria and the leaf blight.

Best varieties are Beder Wood (S), Bubach (P), Haverland (P), Belmont (S) and Sharpless (S).

General.

A weed is a plant out of place.

One year's seeding is seven years' weeding.

Weight of excrement solid and liquid voided daily by an ox of ordinary size is estimated at one hundred and twenty-six pounds, — fifty-six solid and seventy liquid.

The horse produces three-fourths of the weight of its food in manure, and makes twelve tons in the year.

A farm should manure itself once in four years, at the rate of sixteen tons per acre.

The cow voids 20,000 pounds of urine in a year; the horse voids 4,380 pounds; the pig voids 1,200 pounds; the sheep, 380 pounds.

Fourteen pounds of straw (cut) will absorb twenty-two and one-half pounds of urine or liquid manure.

Vitality of Seeds.

Onion, parsnip, leeks, one year; beans, peas, peppers, rhubarb, sage, two years; asparagus, endive, lettuce, parsley, spinach, radish, three years; broccoli, cauliflower, cabbage, celery, turnip, four years; beet, cucumber, melon, pumpkin, squash, tomato, five years.

Rule for determining the number of plants required per acre at a certain distance apart each way: Multiply the distance between the plants each way, and divide 43,560 (number of square feet in an acre) by the product, thus: —

$$3 \times 3 = 9 \,\overline{)\,43{,}560}$$

4,840 — number of plants.

BOOKS WORTH READING.

HENRY H. GOODELL.

Agriculture.

Lloyd — Science of Agriculture.
Waring — Elements of Agriculture.
Wrightson — Agricultural Text-book.
Winslow — Principles of Agriculture.
Miles and Shaw — First Principles of Agriculture.
Fream — Elements of Agriculture.
Gaye — Nature's Farm.
Darwin — Formation of Vegetable Mould by the Action of Earthworms.

Agricultural Chemistry.

Lawes and Morton — Soil of the Farm.
Warington — Chemistry of the Farm.
Johnson — How Crops Grow.
Johnson — How Crops Feed.
Storer — Agriculture in Some of its Relations to Chemistry.
Fream — Soils and their Properties.

Botany and Floriculture.

Long — Ornamental Gardening.
Newell — Reader in Botany.
Bailey — Talks Afield.
Fuller — Propagation of Plants.
Masters — Plant Life on the Farm.
Darlington — American Weeds and Useful Plants.
Ward — Diseases of Plants.
Ellwanger — The Rose.
Wood — Fourteen Weeks in Botany.
Henderson — Practical Floriculture.

Crops.

Morrow and Hunt — Soils and Crops of the Farm.
Wrightson — Farm Crops.
Wrightson — Fallow and Fodder Crops.
Smith — Diseases of Field and Garden Crops.
Griffiths — Diseases of Crops, and their Remedies.
Carman — New Potato Culture.
Fream — Rothamsted Experiments on Wheat, Barley, etc.

Dairy.

Flint — Milch Cows and Dairy Farming.
Sheldon — The Farm and the Dairy.
Long — Dairy Farm.

Drainage.

Chamberlain — Practical Drainage.
French — Farm Drainage.
Waring — Draining for Profit.
Klippart — Land Drainage.
Miles — Land Draining.

Ensilage.

Cooke — Silos and Ensilage.
Ross — Practical Treatise on Ensilage.
Potter — Construction of Silos.
Nesbit — Silos and Ensilage.

Entomology.

Saunders — Insects Injurious to Fruits.
Harris — Insects Injurious to Vegetation.
Weed — Insects and Insecticides.
Treat — Injurious Insects of Farm and Garden.
Cook — Manual of the Apiary.
Cook — Bee-keeping.
Fernald — Butterflies of Maine.
Fernald — Orthoptera of New England.

Feeding.

Armsby — Manual of Cattle Feeding.
Stewart — Feeding Cattle.
Quincy — Essays on Soiling of Cattle.
Henry — Cattle Feeding, in "Special Report on Diseases of Cattle" (government publication).

FERTILIZERS.

Gregory — Fertilizers.
Ville (*Crookes*) — Artificial Manures.
Dana — Muck Manual for Farmers.
Harris — Talks on Manures.
Harlan — Farming with Green Manures.
Griffiths — Treatise on Manures.
Griffiths — Manures, and Their Uses.
Ville — Perplexed Farmer.

FORESTRY.

Apgar — Trees of Northern United States.
Newhall — Trees of North-eastern America.
Fuller — Practical Forestry.
Fuller — Forest Tree Culturist.
Ward — The Oak.

FRUITS.

Fuller — Small Fruit Culture.
Downing — Fruit and Fruit Trees of America.
Thomas — American Fruit Culturist.
Barry — Fruit Garden.
Strong — Fruit Culture and the Laying out and Management of a Country House.
Weed — Spraying Crops, why, when and how.
Maynard — Practical Fruit Grower.
Bailey — Horticultural Rule Book.
Bailey — Nursery Book.
Scribner — Fungous Diseases of the Grape.

GRASS.

Beal — Grasses of North America for Farmers.
Hackel — The True Grasses.
Roland — Management of Grass Lands.

HYGIENE.

Prudden — Dust and its Dangers.
Prudden — Drinking Water and Ice Supplies.
Prudden — Story of the Bacteria.

LIVE STOCK.

Curtis — Horses, Cattle, Sheep and Swine.
Herbert — Hints to Horse Keepers.

Sanders — Breeds of Live Stock.
Wallace — Farm Live Stock.
Roland — Stock-keeping and Stock-raising.
Sturtevant — The Dairy Cow; a monograph on the Ayrshire.
Hazard — The Jersey, Alderney and Guernsey; Their History and Management.
Linsley — Jersey Cattle in America.
Linsley — The Morgan Horse.
Darwin — Animals and Plants under Domestication.

Market Gardening.

Henderson — Gardening for Profit.
Rawson — Success in Market Gardening.
Greiner — How to make the Garden Pay.
Vilmorin — Vegetable Garden.

Meteorology.

Johnson — Sunshine.
Lewis — Air and Water.
Smith — Air and Rain.
Greely — American Weather.

Physical Geography.

Shaler — Aspects of the Earth.
Marsh — The Earth as modified by the Action of Man.
Shaler — Nature and Man in America.
Ball — Causes of an Ice Age.

Political Science.

Dole — The American Citizen.
Bowker — Economics for the People.
Symes — A Short Text-book on Political Economy.
Walker — Political Economy (Briefer course).
Ely — Political Economy (Chautauqua series).
Cossa — Taxation, Principles and Methods.
Shaw — The National Revenues.
Ely — Taxation in American States and Cities.
Holyoake — History of Co-operation.

Poultry.

Profits in Poultry (Orange Judd).
Felch — Poultry Culture.

Sheep.

Randall — Practical Shepherd.

Stock Breeding.

Miles — Stock Breeding.
Sanders — Horse Breeding.
Warfield — Cattle Breeding.

Swine.

Coburn — Swine Husbandry.

Veterinary.

Law — Farmers' Veterinary Adviser.
Smith — Manual of Veterinary Hygiene.
Special Report on Diseases of the Horse (government publication).
Special Report on Diseases of Cattle (government publication).
Special Report on Diseases of Sheep (government publication).
Miles — The Horse's Foot, and how to keep it sound.